



GLNG

Gas Transmission Pipeline

EPBC Environmental Management Plan Mainland GTP

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Appendices

Appendix A – Erosion and Sediment Control Plan (ESCP)

Appendix B – Species Management Plan (SMP)

Appendix C – Significant Species Management Plan (SSMP)

Appendix D – Pest and Weed Management Plan (PWMP)

Appendix E – Mosquitoes and Midges Management Plan (MMMP)

Appendix F – Waste Management Plan (WM Plan)

Appendix G – Landscape Rehabilitation Management Plan (LRMP)

Appendix H – Noise Contours and Tables



ABBREVIATIONS

Abbreviation	Description
AASS	Actual Acid Sulfate Soils
ACHA	Aboriginal Cultural Heritage Act
AIM	Audit and Inspection Manager
AOPC	Area of Potential Concern
APIA	Australian Pipeline Industry Association
APIA Code	<i>Australian Pipeline Industry Association Code of Environmental Practice for Onshore Pipelines</i>
APLNG	Australia Pacific Liquefied Natural Gas
AS	Australian Standard
ASS	Acid Sulfate Soil
ASSMP	Acid Sulfate Soil Management Plan
AS/NZS	Australian Standard/New Zealand Standard
BAAM	Biodiversity Assessment and Management
CAEMP	Contractors Award Environmental Management Plan
CEMP	Construction Environmental Management Plan
CG	Coordinator General
CHMP	Cultural Heritage Management Plan
CICGSDA	Common Infrastructure Corridor Gladstone State Development Area
cm	Centimetre
CMP	Construction Management Plan
CO ₂	Carbon dioxide
CPIC	Common Pipeline Infrastructure Corridor
CSG	Coal Seam Gas
dB	Decibel
DEEDI	Department of Employment, Economic Development and Innovation
DERM	Department of Environment and Resource Management
DEWHA	Department of Environment, Water, Heritage and the Arts
DIP	Department of Infrastructure and Planning
DIWA	Directory of Important Wetlands in Australia
DMP	Dredge Management Plan
DP	Decommissioning Plan
DPI&F	Department of Primary Industries and Fisheries (now DEEDI)
DSEWPC	Department of Sustainability, Environment, Water, Population and Communities
DTMR	Department of Transport and Main Roads
E	Endangered
EA	Environmental Authority
EC	Electrical Conductivity
EHSMS	Environment, Health and Safety Management System
EHS&S	Environmental, Health, Safety and Security
EIS	Environmental Impact Statement
EM Plan	Environmental Management Plan
EO	Environmental Officer
EP Act	<i>Environmental Protection Act 1994</i>
EPA	Environmental Protection Agency (now DERM)
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>



Abbreviation	Description
ERA	Environmentally Relevant Activity
ERP	Emergency Response Plan
ESA	Environmentally Sensitive Area
ESCP	Erosion and Sediment Control Plan
ESP	Exchangeable Sodium Percentage
EVNT	Endangered, Vulnerable and Near Threatened
FA	Financial Assurance
FEED	Front End Engineering Design
FMP	Fauna Management Plan
GBRMP	Great Barrier Reef Marine Park
GBRMPA	Great Barrier Reef Marine Park Authority
GBR WHA	Great Barrier Reef World Heritage Area
GBR Region	Great Barrier Reef Region
GLNG	Gladstone Liquefied Natural Gas
GPS	Global Positioning System
GQAL	Good Quality Agricultural Land
GSDA	Gladstone State Development Area
GTP	Gas Transmission Pipeline
ha	Hectares
HAT	Highest Astronomical Tide
HDD	Horizontal Directional Drilling
HDPE	High Density Polyethylene
Hz	Hertz
ILUA	Indigenous Land Use Agreement
IMP	Integrity Management Plan
IMS	Incident Management System
kg	Kilograms
km	Kilometres
LAT	Lowest Astronomical Tide
LC	Least Concern
LNG	Liquefied Natural Gas
LPG	Liquid Petroleum Gas
LP Act	<i>Land Protection (Pest and Stock Route Management) Act 2002</i>
LRMP	Landscape Rehabilitation Management Plan
m	Metres
M	Medium
Ma	Marine
Mi	Migratory
MLV	Mainline Valve
mm	Millimetres
MMMP	Mosquito and Midge Management Plan
MSDS	Material Safety Data Sheet
Mtpa	Million tonnes per annum
NATA	National Association of Testing Authorities
NC Act	<i>Nature Conservation Act 1992</i>
NDT	Non-destructive Testing
NGL	Natural Ground Level





Abbreviation	Description
NIC	Northern Infrastructure Corridor
N/A	Not applicable
NT	Near Threatened
OC	Of Concern
OH&S	Occupational Health and Safety
OMP	Operational Management Plan
PASS	Potential Acid Sulfate Soil
PCCC	Port Curtis Coral Coast
P&G Act	<i>Petroleum and Gas (Production & Safety) Act 2004</i>
pH	Potential of Hydrogen
PJ	Petrajoules
PPL	Petroleum Pipeline Licence
PSI	Preliminary Site Investigation
PWMP	Pest and Weed Management Plan
QCLNG	Queensland Curtis Liquefied Natural Gas
QGP	Queensland Gas Pipeline
Qld	Queensland
QLUMP	Queensland Land Use Mapping Program
QPIF	Queensland Primary Industries and Fisheries
QPS	Queensland Police Service
QR	Queensland Rail
RE	Regional Ecosystem
REDD	Regional Ecosystem Description Database
RNE	Register of the National Estate
RoW	Right-of-Way
s	Second
Safety IMP	Safety Incident Management Plan
SALNG	The Shell CSG (Australia) Pty Ltd LNG
SAP	Special Area Plans
SDPWO Act	<i>State Development and Public Works Act 1971</i>
SEIS	Supplementary Environmental Impact Statement
SEPM	Santos Environmental Pipeline Manager
SIMP	Santos Incident Management Plan
Social IMP	Social Impact Management Plan
SMP	Species Management Plan
SSMP	Significant Species Management Plan
Sustainability MP	Sustainability Management Plan
TAF	Temporary Accommodation Facility
TSS	Total Suspended Solids
Type A	Type A restricted plant under the provisions of the NC Act
VM Act	<i>Vegetation Management Act 1999</i>
Waste MP	Waste Management Plan
WONS	Weeds of National Significance
WHA	World Heritage Areas
\$	Australian dollars
"	Inch
%	Percent





Abbreviation

hr/yr
>

Description

Hour per year
Greater than

1. Introduction

1.1 Background

The GLNG Project involves:

- Exploration and production of CSG in the Surat and Bowen Basin gas fields
- Construction and operation of an approximate 420 km GTP from the CSG fields in Roma and Fairview to the LNG Facility on Curtis Island
- Construction and operation of a gas liquefaction and export facility on Curtis Island and associated infrastructure

1.1.1 Commonwealth legislation and approval

Separate referrals were submitted under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) for the various components of the GLNG Project, including the GTP (2008/4096).

On 22 October 2010, in accordance with the EPBC Act, the Minister approved the development, construction, operation and decommissioning of the GTP (and the other components of the GLNG Project). Conditions 2-4 of the EPBC Act approval for the GTP require an Environmental Management Plan (EM Plan) to be submitted to the Minister for approval. This EM Plan addresses those conditions.

1.1.2 State legislation and approval

On 16 July 2007, the Queensland Government declared the Project to be a 'significant project requiring an Environmental Impact Statement'. Throughout 2008 and 2009 an environmental impact statement (EIS) was prepared for the proposed Project. The EIS report was approved by the Coordinator-General (CG) for release for public and advisory agency comment from 20 June to 17 August 2009. Submissions covered a broad range of environmental, social, accommodation, materials and employee transport, infrastructure location and regulatory approval matters.

The CG requested additional information about the EIS and the project in the form of a supplementary EIS (SEIS). A SEIS was subsequently prepared and provided to the Department of Infrastructure and Planning (now the Department of Local Government and Planning (DLGP)) in December 2009. The SEIS provided additional information to address the EIS submissions received, and identified refinements to project design.

A CG Report was released in May 2010, which allowed the Project to proceed, subject to Federal and other relevant State approvals.

1.1.3 Mainland EM Plan

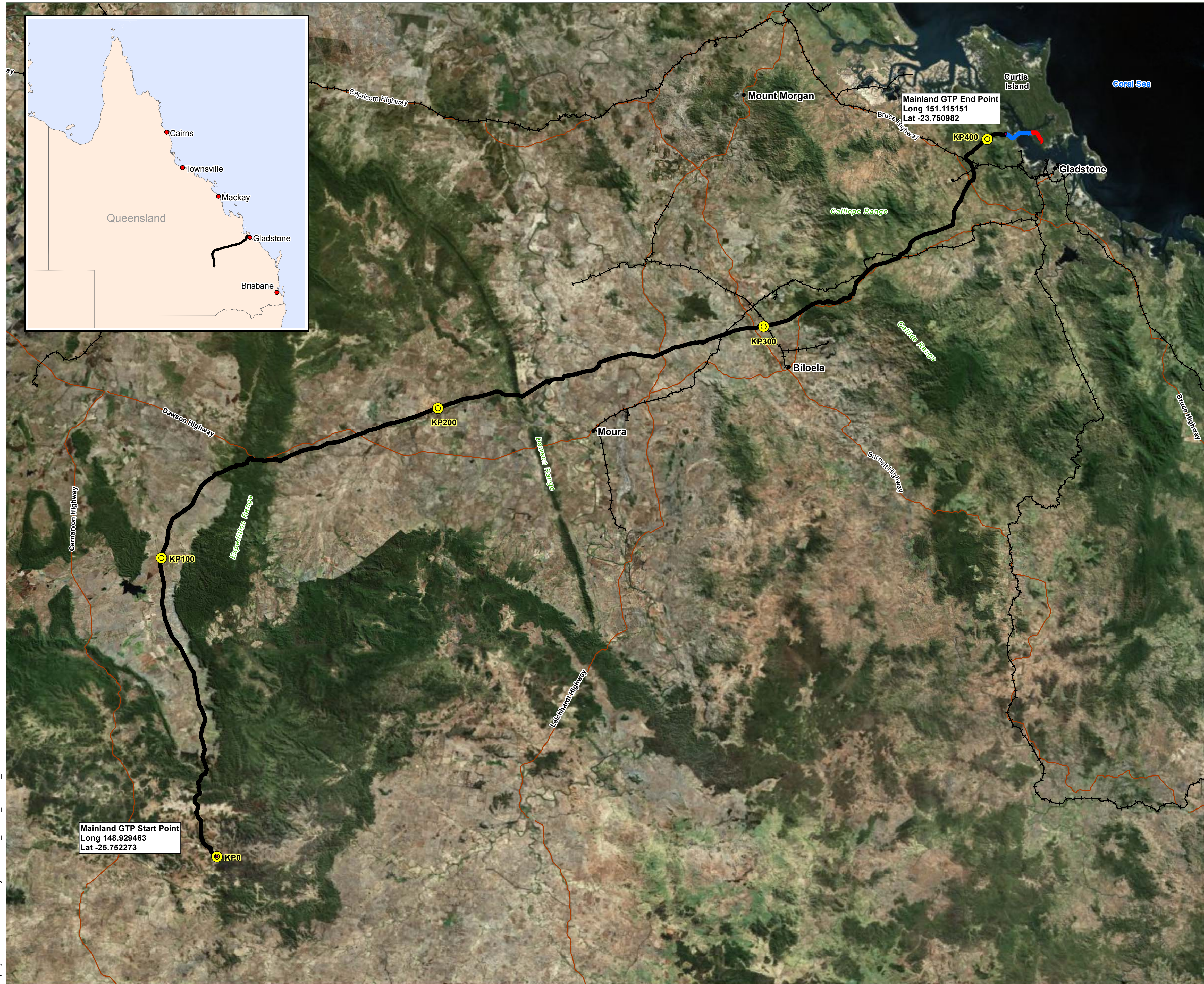
The proposed section of GTP that is dealt with in this EM Plan is referred to as the Mainland GTP RoW (Right of Way). The Mainland GTP RoW will originate at the gas fields at Roma and Fairview and connect to the Marine crossing section of the GTP on Port Curtis, spanning a distance of approximately 406 km (refer Figure 1.1). Separate EM Plans will be submitted for the Marine Crossing and Curtis Island sections of the GTP.

The Mainland GTP RoW construction methodology is presented in Chapter 2 and provides details in relation to the open trenching process, construction of pipe storage areas and construction camps along the Mainland GTP RoW.



Mainland GTP EM Plan

- Gas Transmission Pipeline (GTP)
- Mainland GTP EM Plan
 - Marine Crossing GTP EM Plan
 - Curtis Island GTP EM Plan
 - Kilometre Post Distance Marker (km)
 - Rail
 - Major Road



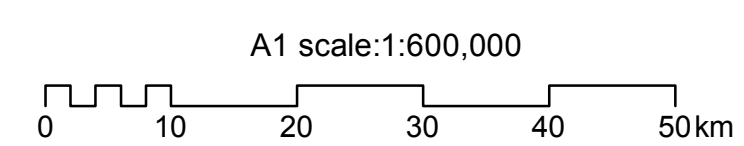
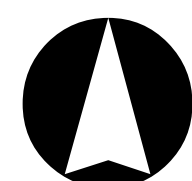
Source:
Gas Transmission Pipeline (GTP): Santos, Jan 2011.
Aerial: BING, Feb 2011.

Note:
Lat/Long given in GDA94

Locality Plan Figure 1.1

Date: 27/06/2011

Version: c



GLNG No: 3381-40-0400
Coordinate system: GCS_GDA_1994

This EM Plan has been prepared to satisfy the relevant parts of the CG Report and support the Environmental Authority (EA) application to the Department of Environment and Resource Management (DERM) for a Chapter 5A petroleum activity pursuant to the Queensland *Environmental Protection Act 1994* (EP Act). The EA and its EM Plan address how the environmental impacts of the proposed works associated with construction and operation (including decommissioning) of the Mainland GTP will be managed and licensed under Petroleum Pipeline Licence (PPL) No. 166.

It also addresses the requirements of conditions 2-4 of the EPBC Act approval.

1.2 Purpose of this EM Plan

An EA pursuant to the EP Act is required to support the approval of a Chapter 5A Level 1 petroleum activity to be carried out under the Petroleum Pipeline Licence No. 166 to be issued pursuant to the *Petroleum and Gas (Production and Safety) Act 2004* (P&G Act).

The purpose of an EM Plan as defined in the EP Act is to identify the environmental values affected by the proposed activity and the mitigation and management commitments necessary to protect those values. The EM Plan is therefore to assist:

- The administering authority (DERM) to make a determination on the EA application for the Mainland GTP

This EM Plan is also submitted in accordance with conditions 2-4 of the EPBC Act approval. This EM Plan is also a planning document used to demonstrate that the Proponent has considered all potential impacts of the proposed construction and operation (including decommissioning) of the Mainland GTP. In particular, this EM Plan:

- Provides a description of the Mainland GTP, including the project rationale and details of the proponent and applicable legislation
- Describes the Mainland GTP construction methodology
- Identifies the environmental values that may be affected
- Is a planning document that informs the detailed design, construction and operational phases of the Project
- Identifies and assesses cumulative impacts
- Identifies environmental protection commitments and environmental management procedures
- Provides evidence of practical and achievable plans to ensure that the project's environmental requirements are complied with
- Is an integrated plan for monitoring, assessing and controlling potential impacts
- Provides a common focus for local, State and Commonwealth authority approval conditions and compliance with policies and conditions
- Provides evidence to the broader community that the Mainland GTP portion will be managed in an environmentally acceptable manner that is consistent with the other components of the Project.

1.3 Scope of this EM Plan

As required in the CG Report and the EPBC Act approval, the GTP EM Plans are to be submitted (Mainland Section, Marine Crossing Section and Curtis Island Section) to support new EAs for the relevant PPL's and to satisfy conditions 2-4 of the EPBC Act approval. Each EM Plan has been prepared as a 'stand alone' document to be used as the basis for managing activities as the Project progresses.

This EM Plan describes the Mainland GTP (refer Figure 1.1), the surrounding and associated environmental values, the potential environmental impacts and the proposed management and mitigation measures to minimise potential impacts.

This Mainland GTP EM Plan has been prepared based on the findings outlined in the EIS (March 2009), studies undertaken during the preparation of the SEIS, and additional work undertaken and conditions specified as per the CG Report (May 2010) and the EPBC Act approval.

This EM Plan has been prepared in accordance with Queensland Government guidelines: *Preparing an EM Plan for Coal Seam Gas (CSG) Activities* (DERM, 2010), and covers construction and operational activities associated with the Mainland GTP RoW. It is also consistent with the Australian Pipeline Industry Association's (APIA's) Code of Environmental Practice (2009).

1.4 EM Plan Format

Table 1.1 below identifies in which chapter of this EM Plan the various relevant environmental parameters are addressed. Each Chapter addresses the preconstruction, detailed design, construction and operational phases of the Mainland GTP. Environmental sub plans for each element where relevant have been developed and include specific mitigation measures and controls to address the impacts resulting from the construction and operation of the Mainland GTP.

Table 1.1 EM Plan elements

EM Plan chapter	Element addressed	Related Management Plan
Chapter 1	Introduction	No plan identified for this Chapter
Chapter 2	Project description	Construction Management Plan Operational Management Plan (OMP)
Chapter 3	Environmental management system	Project Health Safety and Security Management Plan
Chapter 4	Financial assurance	No plan identified for this Chapter
Chapter 5	Air quality	No plan identified for this Chapter
Chapter 6	Dams	No plan identified for this Chapter
Chapter 7	Land management	Erosion and Sediment Control Plan (ESCP)
Chapter 8	Land tenure and use	No plan identified for this Chapter
Chapter 9	Flora and fauna	Species Management Plan (SMP) Significant Species Management Plan (SSMP) Pest and Weed Management Plan (PWMP)
Chapter 10	Noise	No plan identified for this Chapter
Chapter 11	Social	Social Impact Management Plan (SIMP) Mosquitoes and Midges Management Plan (MMMP)
Chapter 12	Heritage	Cultural Heritage Management Plan (CHMP)
Chapter 13	Waste	Waste Management Plan (Waste MP)
Chapter 14	Water	Hydrostatic Testing Management Plan (HTMP) (to be developed by Contractor)
Chapter 15	Rehabilitation	Landscape and Rehabilitation Management Plan (LRMP)

The above elements are addressed in terms of environmental protection objectives, standards and measurable indicators, control strategies and corrective actions, as detailed in Table 1.2.

Table 1.2 Structure of environmental protection commitments, objectives and control strategies

Environmental protection objective	The objectives are to define the outcomes that are intended to be achieved
Specific objectives	The specific objectives outline limits or targets that are to be used when auditing the performance of the management/environmental protection objective
Control strategies	Appropriate measures to be taken to ensure that the objectives are being met or achieved
Performance indicators	Indicators to be used to gauge the level of compliance and performance of the control strategy
Monitoring, recording and corrective actions	Monitoring, recording and corrective actions have been addressed in Chapter 3 (Environmental Management System)

During the pre-construction, construction and operational phases of the Project, this EM Plan will be reviewed and updated to:

- Incorporate the outcomes of detailed design and contractor requirements
- Include the organisational structure for operations and allocation of responsibilities in line with the organisational structure
- Establish reporting lines based on the organisational structure
- Include relevant approval conditions resulting from the approval process and subsequent permits, authorities and licences relevant to the pipeline's operation
- Review control strategies, objectives and performance indicators to ensure that these are appropriate for operations
- Include reference to the latest versions of detailed design drawings, particularly those that reference areas of environmental value
- Review inspection and audit schedules and inclusion of specific locations where a higher level of inspection is required (eg to monitor rehabilitation success of sensitive areas)

1.5 Description of petroleum tenures/petroleum authorities

1.5.1 Project name and general location

As part of the GLNG Project, work will be undertaken to develop, design, construct, operate and decommission a 420 km pipeline network to link CSG fields near Roma and Fairview in Queensland to the proposed LNG facility located on Curtis Island.

This EM Plan has been prepared for the 406 km Mainland GTP section which runs from the CSG fields at Fairview to Port Curtis (see Figure 1.1).

1.5.2 Relevant resource authorities

This EM Plan relates to PPL No. 166.

1.5.3 Relevant blocks and sub-blocks

A summary of the blocks traversed by the Mainland GTP which are part of the PPL area is provided in Table 1.3. The location of each block is illustrated in Figure 1.2.

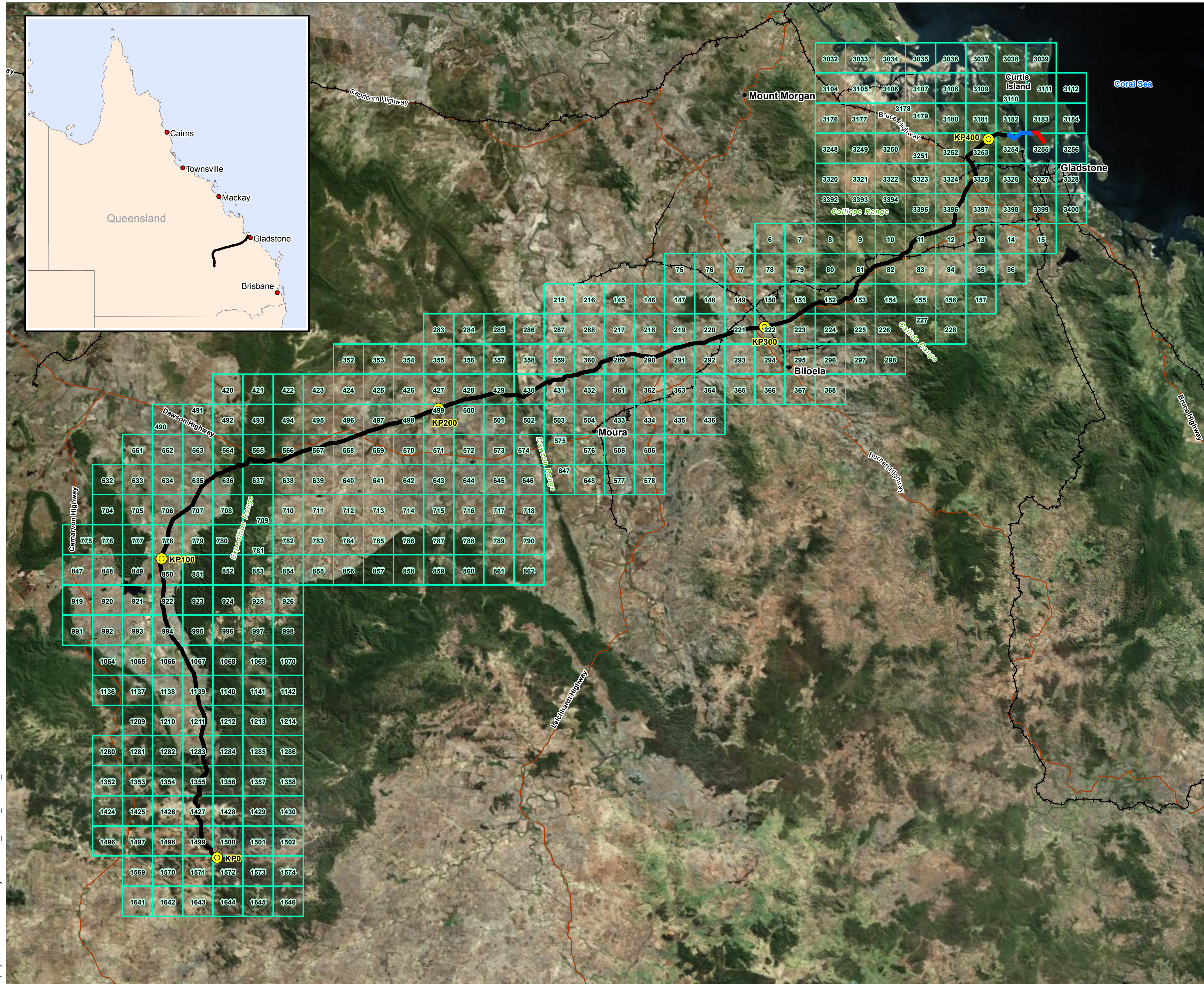
Table 1.3 Relevant blocks traversed by the Mainland GTP RoW

PPL Blocks	Map Name	PPL Blocks	Map Name	PPL Blocks	Map Name
1572	Charleville	1499	Charleville	1355	Charleville
1500	Charleville	1427	Charleville	1283	Charleville



Mainland GTP EM Plan

- Gas Transmission Pipeline (GTP)
 - Mainland GTP EM Plan
 - Marine Crossing GTP EM Plan
 - Curtis Island GTP EM Plan
- Kilometre Post Distance Marker (km)
- Petroleum Pipeline Licence (PPL) Block
- Rail
- Major Road

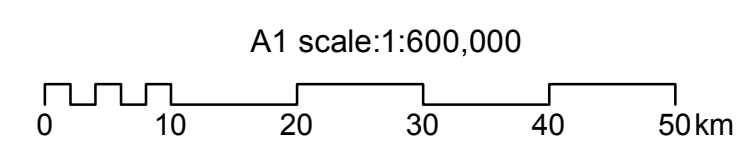
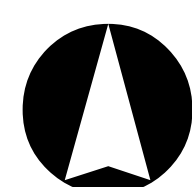


Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Aerial: BING, Feb 2011.
 PPL Blocks: Santos, Feb 2011.

PPL Blocks Figure 1.2

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Map by: RB



GLNG No: 3381-40-0401
 Coordinate system: GCS_GDA_1994

Date: 27/06/2011

Version: c

PPL Blocks	Map Name	PPL Blocks	Map Name	PPL Blocks	Map Name
1211	Charleville	496	Charleville	221	Brisbane
1139	Charleville	497	Charleville	222	Brisbane
1066	Charleville	498	Charleville	223	Brisbane
1067	Charleville	499	Charleville	151	Brisbane
994	Charleville	427	Charleville	152	Brisbane
922	Charleville	428	Charleville	153	Brisbane
850	Charleville	429	Charleville	81	Brisbane
778	Charleville	430	Charleville	82	Brisbane
706	Charleville	431	Charleville	10	Brisbane
707	Charleville	432	Charleville	11	Brisbane
635	Charleville	360	Charleville	12	Brisbane
636	Charleville	289	Brisbane	3396	Rockhampton
637	Charleville	290	Brisbane	3324	Rockhampton
565	Charleville	291	Brisbane	3325	Rockhampton
566	Charleville	292	Brisbane	3253	Rockhampton
567	Charleville	219	Brisbane	3254	Rockhampton
568	Charleville	220	Brisbane		

1.5.4 Real property descriptions

The land tenure within the Mainland GTP RoW varies between freehold, leasehold and state land. Freehold land covers the majority of the Mainland GTP RoW with the remainder being leasehold, State land and easements. Further details regarding freehold and leasehold properties are provided in Chapter 8.

Within the Mainland GTP RoW, significant land includes the Callide Timber Reserve, which serves as a state land allotment and falls across part of the Mainland GTP RoW. Mount Stowe State Forest is within the corridor boundaries, and the remainder of the Gladstone-Moura sector is a combination of leasehold and freehold allotments.

The Moura to Injune sector follows a similar pattern to that above. Leasehold and freehold allotments are in the majority, with leasehold being the most common. The Expedition State Forest and other state land allotments also exist.

1.6 Potentially affected properties

As the Mainland section of the GTP is primarily dominated by agriculture, the population of the towns within close vicinity to the Mainland GTP RoW is minimal. At present, there are 29 residential dwellings located within a 5km wide corridor of the Mainland GTP (URS, 2009).

The closest large population centre to the GTP is Gladstone; however there are a number of secondary centres located along the Mainland GTP which include Beecher, Mount Larcom, Thangool, Biloela, Banana, Baralaba, Rolleston, Wyseby and Injune.

1.7 Relevant Legislation

Table 1.4 outlines the legislation and policies that have been taken into account in developing this EMP.

Table 1.4 Applicable legislation and governing authorities

Legislation	Assessing Authority	Relevant chapter(s) addressing legislation
Commonwealth legislation		
<i>Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)</i>	Department of Sustainability, Environment, Water, Population and Communities (DSEWPC)	Chapter 9 - Flora and fauna
<i>Native Title Act 1993</i>	DSEWPC	Chapter 12 – Heritage Chapter 11 - Social
National Environmental Protection (Movement of Controlled Waste between States and Territories) Measure	Environment Protection and Heritage Council	Chapter 13 – Waste
State legislation		
<i>Petroleum and Gas (Production and Safety) Act 2004</i>	Department of Employment, Economic Development & Innovation (DEEDI)	Chapter 2 - Project description
<i>Environmental Protection Act 1994 (EP Act)</i>	Department of Environment and Resource Management (DERM)	This EM Plan
<i>Environmental Protection Regulation 2008</i>	DERM	This EM Plan
<i>Sustainable Planning Act 2009 (SPA)</i>	DERM	Chapter 8 - Land tenure and use
<i>Environmental Protection (Waste Management) Policy 2000</i>	DERM	Chapter 13 – Waste
<i>Environmental Protection (Waste Management) Regulation 2000</i>	DERM	Chapter 13 – Waste
<i>Environmental Protection (Air) Policy 2008</i>	DERM	Chapter 5 – Air Quality Chapter 7 – Land Management
<i>Environmental Protection (Noise) Policy 2008</i>	DERM	Chapter 10 – Noise Chapter 11 – Social
<i>Environmental Protection (Water) Policy 2009</i>	DERM	Chapter 14 – Water
<i>State Development and Public Works Organisation Act 1971 (SDPWO Act)</i>	Department of Employment, Economic Development and Innovation (DEEDI)	Chapter 2 – Project description
<i>Nature Conservation Act 1992 (NCA)</i>	DERM	Chapter 9 - Flora and fauna
<i>Aboriginal Cultural Heritage Act 2003 (ACH Act)</i>	DERM	Chapter 12 - Heritage
<i>Torres Strait Islander Cultural Heritage Act 2003</i>	DERM	Chapter 12 – Heritage
<i>Transport Infrastructure Act 1994 (TIA)</i>	Department of Transport and Main Roads (DTMR)	Chapter 2 - Project description
<i>Transport Operations (Road Use Management) Act 1995</i>	DTMR	Chapter 2 - Project description
<i>Water Act 2000</i>	DERM	Chapter 14 - Water
<i>Fisheries Act 1994</i>	DEEDI (Queensland Primary Industries and Fisheries)	Chapter 9 - Flora and fauna
<i>Forestry Act 1959</i>	DERM	Chapter 9 - Flora and fauna
<i>Land Act 1994</i>	DERM	This EM Plan
<i>Land Protection (Pest and Stock Route Management) Act 2002</i>	DERM	Chapter 9 - Flora and fauna Chapter 13 - Waste

Legislation	Assessing Authority	Relevant chapter(s) addressing legislation
<i>Dangerous Goods Safety Management Act 2001</i>	Department of Justice and Attorney-General	Chapter – 13 Waste
<i>Dangerous Goods Safety Management Regulation 2001</i>	Department of Justice and Attorney-General	Chapter 13 – Waste
SPP 1/92 – <i>Development and the Conservation of Agricultural Land</i>	State government	Chapter 8 - Land tenure and use
SPP 2/02 – <i>Planning and Managing Development Involving Acid Sulfate Soils</i>	State government	Chapter 7 - Land management
Waste Reduction and Recycling Strategy 2010 – 2020	State Government	Chapter 13 – Waste

1.8 Environmentally Sensitive Areas

In accordance with the CG Report, Environmentally Sensitive Areas (ESAs) within and adjacent to the RoW must be considered. For the purposes of this EM Plan, Category A and B ESAs have been defined pursuant to Sections 25 and 26 of the *Environmental Protection Regulation 2008*, whilst Category C ESA's have been defined pursuant to the DERM guideline "*Preparing an Environmental Management Plan (EM Plan) for Coal Seam Gas (CSG) Activities*".

The application of the ESAs to the Mainland GTP RoW specifically dictates the width of the RoW. That is, where an ESA applies to a certain section, the RoW is reduced accordingly from 40 m to 30 m.

Table 1.5 below identifies the Category A, B and C ESA's that have been incorporated and addressed within this EM Plan.

Table 1.5 Environmentally Sensitive Area Classification*

Category	ESA definition	Addressed in Chapter
A	<ul style="list-style-type: none"> • Any of the following under the <i>Nature Conservation Act 1992</i>: <ul style="list-style-type: none"> – a national park (scientific) – a national park – a national park (Aboriginal land) – a national park (Torres Strait Islander land) – a national park (Cape York Peninsula Aboriginal land) – a national park (recovery) – a conservation park – a forest reserve • The wet tropics area under the <i>Wet Tropics World Heritage Protection and Management Act 1993</i> • The Great Barrier Reef Region under the <i>Great Barrier Reef Marine Park Act 1975</i> (Commonwealth) • A marine park under the <i>Marine Parks Act 2004</i>, other than a part of the park that is a general use zone under that Act 	No Category A ESA's are located within the Mainland GTP RoW

Category	ESA definition	Addressed in Chapter	
B	<ul style="list-style-type: none"> Any of the following areas under the <i>Nature Conservation Act 1992</i>: <ul style="list-style-type: none"> a coordinated conservation area a wilderness area a World Heritage management area an international agreement area an area of critical habitat or major interest identified under a conservation plan^[1] an area subject to an interim conservation order 	Chapter 9 – Flora and Fauna	
	<ul style="list-style-type: none"> An area subject to the following conventions to which: <ul style="list-style-type: none"> the 'Convention on the Conservation of Migratory Species of Wild Animals' (Bonn, 23 June 1979) the 'Convention on Wetlands of International Importance, especially as Waterfowl Habitat' (Ramsar, Iran, 2 February 1971) the 'Convention Concerning the Protection of the World Cultural and Natural Heritage' (Paris, 23 November 1972) 		
	<ul style="list-style-type: none"> A feature protection area, State forest park or scientific area under the <i>Forestry Act 1959</i> 		
	<ul style="list-style-type: none"> A declared fish habitat area under the <i>Fisheries Act 1994</i> 		
	<ul style="list-style-type: none"> A place in which a marine plant under the <i>Fisheries Act 1994</i> is situated 		
	<ul style="list-style-type: none"> An endangered regional ecosystem identified in the database known as the 'Regional ecosystem description database' kept by the department 		
	<ul style="list-style-type: none"> A zone of a marine park under the <i>Marine Parks Act 2004</i> 		n/a
	<ul style="list-style-type: none"> An area to the seaward side of the highest astronomical tide 		n/a
	<ul style="list-style-type: none"> The following under the <i>Queensland Heritage Act 1992</i>: <ul style="list-style-type: none"> a place of cultural heritage significance a registered place 		Chapter 12 – Cultural Heritage
	C		<ul style="list-style-type: none"> Nature Refuges under the <i>Nature Conservation Act 1992</i>
<ul style="list-style-type: none"> Koala Habitat Areas as defined under the <i>Nature Conservation Act 1992</i> 			
<ul style="list-style-type: none"> State Forests or Timber Reserves as defined under the <i>Forestry Act 1959</i> 			
<ul style="list-style-type: none"> Resources reserves under the <i>Nature Conservation Act 1992</i> 			
<ul style="list-style-type: none"> An area identified as 'essential habitat', defined under the <i>Nature Conservation Act 1992</i> 			
<ul style="list-style-type: none"> "Of Concern" regional ecosystems identified in the database maintained by DERM called 'Regional ecosystem description database' containing regional ecosystem numbers and descriptions 			
<ul style="list-style-type: none"> Declared catchment areas under the <i>Water Act 2000</i> 		Chapter 14 – Water	
<ul style="list-style-type: none"> Any wetland shown on the Map of Referable Wetlands available from DERM's website 			

Table notes: For the purposes of this assessment, Category A and B ESAs have been defined pursuant to Sections 25 and 26 of the *Environmental Protection Regulations 2008*, whilst Category C ESAs have been defined pursuant to the DERM guideline "Preparing an Environmental Management Plan (EM Plan) for Coal Seam Gas (CSG) activities".

^[1] Note: There are currently no declared 'critical habitats' or 'areas of major interest' listed under the *Nature Conservation Act 1992* (DERM 2011)



1.9 Coordinator General Report conditions

The CG report confirmed that the Project could proceed, subject to a number of conditions. Table 1.6 outlines the conditions of the CG report that are relevant to the Mainland GTP, as well as the chapters and sections in which these conditions are addressed in this EM Plan.



Table 1.6 CG Report conditions relevant to the Mainland GTP that are addressed in this EM Plan

Coordinator General Conditions Relevant to the EM Plan	Section Addressed
Appendix 1 – Part 2	
Condition 13: During the detailed design phase of the project and prior to any road or access track upgrade or construction for the project the proponent will consult with DERM to identify, assess and mitigate impacts to terrestrial and aquatic ecosystems and develop an EMP for design and construction of environmental offset and mitigation measures associated with road and access track works, including assessment of any proposed offsets	Access Tracks: Chapter 2 Terrestrial and Aquatic ecosystems: Chapter 9 and Chapter 14
Appendix 3 – Part 1	
Condition 1: East of the Callide Range, the proponent must locate the gas transmission pipeline within the Callide Infrastructure Corridor State Development Area (CICSDA) and Gladstone State Development Area (GSDA)	Chapter 2
Condition4: The proponent is also required to obtain an environmental authority approval from DERM prior to the commencement of construction	This EM Plan will support the bid for approval
Appendix 3 – Part 2	
Condition 3: The proponent must include provisions in the Environmental Management Plan for the gas pipeline, ensuring that, on land identified as being good quality agricultural land (GQAL), the pipeline contractor must:	Chapter 7
a) on completion of construction, remove temporary access tracks	Chapter 7
b) on completion of construction, lightly rip disturbed areas, replace topsoil and return the surface to a land use condition that serves the preconstruction use	Chapter 7
c) on completion of construction, implement land management and erosion control measures, and	Chapter 7
d) on land with GQAL class A, B or C1, bury the pipeline to at least 0.9m below finished land surface, or greater if deep ripping is a normal practice	Chapter 7
Condition 13: A mosquito and midge management plan (MMMP) will be developed as part of the EM Plan and will include:	Mosquito and Midge Management Plan (MMMP) (Appendix E)
a) assessment of work areas to be undertaken prior to works and on an informal basis to identify potential breeding sites;	MMMP (Appendix E)
b) any required specific area control plans based on assessment of potential breeding sites will conform to DERM'S <i>Mosquito Management Code of Practice for Queensland</i> ; and Queensland Health and the relevant local councils will be contacted for assistance in choosing a suitable method	MMMP (Appendix E)
Condition 25: Environmental authorities under section 310M of the EP Act and pipeline licences under section 410 of the <i>Petroleum and Gas (Production and Safety) Act 2004</i> may be issued separately for the following sections of the gas transmission pipeline:	-
a) gas-fields to the Kangaroo Island wetlands	This EM Plan



Coordinator General Conditions Relevant to the EM Plan	Section Addressed
b) Kangaroo Island wetlands and the Narrows	See Marine Crossing EM Plan
c) Curtis Island.	See Curtis Island EM Plan
Appendix 3 – Part 3	
Condition 1: The EM Plan developed in accordance with section 310D of the <i>Environmental Protection Act 1994</i> to support the applications for pipeline leases must provide:	-
a) a construction schedule and methodology including plans and maps showing how the pipeline will be constructed through specific vegetation and soil types, topography and across riparian areas to avoid or minimise environmental harm	Chapter 2
b) details on how the proponent’s pipeline will be constructed in common use infrastructure corridors in conjunction with other pipelines and services to minimise cumulative impacts, both on the mainland and Curtis Island	Chapters 2, 5, 7, 8, 9 10, 11, 12, 13 and 14.
c) details on waste management, treatment and disposal, including hydrostatic test water	Chapter 13
d) a maintenance and rehabilitation plan following construction to protect soil values and prevent weed invasion	Chapter 15, Pest and Weed Management Plan (PWMP) (Appendix D) and Landscape and Rehabilitation Management Plan (LRMP) (Appendix G)
Condition 2: The EM Plan developed in accordance with section 310D of the <i>Environmental Protection Act 1994</i> to support the applications for pipeline leases must:	-
a) be prepared in accordance with the DERM published guideline: Preparing an environmental management plan (EM Plan) for Coal Seam Gas (CSG) activities, where relevant	This EM Plan
b) specifically address:	-
i. the pipeline construction schedule and proposed methodology	Chapter 2
ii. construction in common use infrastructure corridors	Chapter 2
iii. the pipeline route on Curtis Island	n/a (refer Curtis Island EM Plan)
Condition 3: Prior to the commencement of petroleum activities the proponent must provide to DERM for review the following aquatic values impacted by the Gas Transmission Pipeline, including:	Chapter 14
a) a detailed assessment of aquatic values (including animal breeding places) along the pipeline route must be provided. Site specific data must be included that accurately and comprehensively describes the environmental values and ecological condition at each aquatic site. The information must be used to determine the location of each watercourse or wetland crossing and site specific mitigation measures to protect the values identified	Chapter 9 and 14



Coordinator General Conditions Relevant to the EM Plan	Section Addressed
b) the information must also demonstrate that mitigation measures for permanent creek crossings are consistent with AS2885 – <i>Pipelines: Gas, Liquid and Petroleum</i> and the <i>Australian Pipeline Industry Association Code of Environmental Practice</i> . Those documents provide the approach to be taken when determining the optimal route selection as well as engineering standards that must be applied to the construction of the pipeline, including:	Chapter 14
i. minimisation of adverse impacts on fauna and significant habitat areas	Chapter 14
ii. minimisation of impacts on riparian, aquatic and water dependent flora and fauna	Chapter 14
iii. minimise erosion and sediment impacts	Chapter 14
iv. maintain water quality and water flow requirements	Chapter 14
v. maximise rehabilitation success of achieving long term site stability	Chapter 14
c) Soils ground truthing, including identification of all sensitive soil and landform areas along the pipeline corridor including Good Quality Agricultural Land, cross referenced to known information on land units and land systems. Any variation between identified land values and DERM data sets must be identified and explained. An assessment of the potential impacts must be provided along with appropriate mitigation measures and construction methods applicable to the identified soil types or landforms	Chapter 7
d) protection and restoration of good quality agricultural land that could qualify as strategic cropping land under the Government’s draft discussion paper Protection of Strategic Cropping Land;	Chapter 7
e) Hydrostatic test water, including a detailed assessment of impacts from hydrostatic test water along the pipeline route, which must be provided. Source water quality data and characteristics of additives, particularly biocides) must be provided along with the proposed storage, treatment and disposal methods. The information must be used to determine the site specific mitigation measures including monitoring and reporting	Chapter 2
APPENDIX 3 – PART 4	
Condition (A12)	
An Environmental Management Plan (EM Plan) must be implemented that provides for the effective management of the actual and potential impacts resulting from the carrying out of the petroleum activities. Documentation relating to the EM Plan must be kept	Chapter 3
Condition (A13)	
The EM Plan required by condition (A12) must address, at least, the following:	-
1. Describe each of the following:	-
(a) each relevant resource authority for the environmental authority	Chapter 1
(b) all relevant petroleum activities	Chapter 2



Coordinator General Conditions Relevant to the EM Plan	Section Addressed
(c) the land on which the activities are to be carried out	Chapter 7
(d) the environmental values likely to be affected by the activities	Chapters 5, 6, 7, 8, 9, 10, 11, 12, 13 and 14
(e) the potential adverse and beneficial impacts of the activities on the environmental values	Chapters 5, 7, 8, 9, 10, 11, 12, 13 and 14.
2. State the environmental protection commitments the applicant proposes for the activities to protect or enhance the environmental values under best practice environmental management;	Chapters 5, 7, 8, 9, 10, 11, 12, 13 and 14.
3. Include a rehabilitation program for land proposed to be disturbed under each relevant resource authority for the application	Chapter 15, LRMP (Appendix G)
4. State a proposed amount of financial assurance for the environmental authority as part of the rehabilitation program	Chapter 4
5. Training staff in the awareness of environmental issues related to carrying out the petroleum activities, which must include at least:	Chapter 3
(b) Any relevant environmental objectives and targets, so that all staff are aware of the relevant performance objectives and can work towards these	Chapters 3, 5, 7, 8, 9, 10, 11, 12, 13 and 14.
(c) Control procedures to be implemented for routine operations for day to day activities to minimise the likelihood of environmental harm, however occasioned or caused	Chapters 3, 5, 7, 8, 9, 10, 11, 12, 13 and 14.
(d) Contingency plans and emergency procedures to be implemented for non routine situations to deal with foreseeable risks and hazards, including corrective responses to prevent and mitigate environmental harm (including any necessary site rehabilitation)	Chapter 3
(e) Organisational structure and responsibility to ensure that roles, responsibilities and authorities are appropriately defined to ensure effective management of environmental issues	Chapter 3
(f) Effective communication procedures to ensure two-way communication on environmental matters between operational staff and higher management	Chapter 3
(g) Obligations with respect to monitoring, notification and record keeping obligations under the EM plan and relevant approvals	Chapters 3, 5, 7, 8, 9, 10, 11, 12, 13 and 14.
(h) Monitoring of the release of contaminants into the environment including procedures, methods and record keeping.	Chapters 3, 5, 7, 8, 9, 10, 11, 12, 13 and 14.
6. The conduct of periodic reviews of environmental performance and procedures adopted, not less frequently than annually	Chapter 3
7. A program for continuous improvement.	Chapter 3



1.10 EPBC Referral No 2008/4096 conditions

Table 1.7 outlines the conditions of the EPBC approval that are relevant to the Mainland GTP, as well as the chapters and sections in which the conditions are addressed in this EM Plan.



Table 1.7 EPBC conditions relevant to the Mainland GTP that are addressed in this EM Plan

EPBC Conditions Relevant to the EM Plan	Section Addressed
<i>Environmental Management Plan (excluding the Narrows)</i>	-
2. The proponent must prepare an Environmental Management Plan to manage the impacts of construction, operation and decommissioning of the pipeline (other than in relation to the Narrows) on listed threatened species and ecological communities, listed migratory species and values of the World and National Heritage-listed Great Barrier Reef.	This EM Plan
3. The Environmental Management Plan must include:	-
a) provisions for detailed pre-clearance surveys by a suitably qualified ecologist along the entire length of the ROW, in accordance with conditions 5 to 10;	Chapter 9, Table 9.16, Sub-heading - Vegetation clearing
b) measures to minimise native and riparian vegetation clearance and to minimise the impact on listed species, their habitat and ecological communities in accordance with management plans required for MNES under this approval;	Chapter 9, Table 9.16, Sub-heading - Vegetation clearing
c) measures to manage the impact of clearing on each listed species and ecological community in accordance with management plans required for MNES under this approval;	Chapter 9, Table 9.16, Sub-heading - Vegetation clearing
d) measures to regenerate vegetation on the ROW where natural regeneration is not successful to a condition at least equivalent to the ROW condition prior to commencement;	Chapter 15. Landscape and Rehabilitation Management Plan (LRMP) (Appendix G)
e) measures to minimise impacts on fauna during pipeline construction, including:	-
i. measures to protect MNES in the areas of the ROW where trenching is being undertaken, including measures to exclude listed terrestrial fauna from gaining access to those areas of the ROW where trenching is currently being undertaken	Chapter 9, Table 9.16, Sub-headings – Fauna management, Fauna injury and mortality. Significant Species Management Plan (SSMP)
ii. mechanisms to allow fauna to escape from the pipeline trench;	Chapter 9, Table 9.16, Sub-headings – Fauna management, Fauna injury and mortality. SSMP
iii. daily morning surveys for trapped fauna;	Chapter 9, Table 9.16, Sub-heading – Fauna management
iv. mechanisms for a suitably qualified person to relocate fauna; and	Chapter 9, Table 9.16, Sub-headings - Conservation significant fauna species, Fauna injury and mortality. SSMP
v. record keeping for all survey, removal and relocation activities	Chapter 9, Table 9.16, Sub-headings - Conservation significant fauna species, Fauna injury and mortality. SSMP





EPBC Conditions Relevant to the EM Plan	Section Addressed
f) machinery wash down procedures and ongoing monitoring to minimise the spread and establishment of weeds in the ROW. Monitoring of weed infestations within disturbed areas must occur at least monthly during construction and then quarterly for a period of two years after completion of construction. Appropriate weed control measures must be implemented. After the two-year period, the frequency of monitoring must be reconsidered by the proponent, based on the success of control measures, the level of infestations and pipeline maintenance activities;	Pest and Weed MP (PWMP) (Appendix D)
g) measures to manage and control feral animals that may spread due to the establishment of the ROW;	PWMP (Appendix D)
h) measures for the prevention of ignition sources to protect habitat values;	Chapter 9, Table 9.16, Sub-headings – Fire
i) measures for the management of acid sulfate soils	Chapter 7,
4. The Environmental Management Plan must be submitted for the approval of the Minister. Commencement must not occur without approval (except for activities critical to commencement and associated with mobilisation of plant, equipment, materials, machinery and personnel prior to start of pipeline construction which will have no adverse impact on MNES). The approved plan must be implemented.	This EM Plan
<i>Pre-clearance surveys</i>	-
5. Before the clearance of native vegetation in the pipeline ROW, the proponent must:	-
a) undertake pre-clearance surveys for the presence of listed threatened species and migratory species, their habitat and listed ecological communities.	Species Management Plan (SMP). SSMP
b) alternatively, where recent surveys have already been undertaken and those surveys meet the Department's requirements for surveys for the relevant MNES, the proponent may elect to develop management plans based on those surveys in accordance with the requirements of Condition 8	
6. Pre-clearance surveys must:	-
a) for each listed species, be undertaken in accordance with the Department's survey guidelines in effect at the time of the survey. This information can be obtained from http://www.environment.gov.au/epbc/guidelines-policies.html#threatened ;	SMP – Section 2.1.1. SSMP – Section 2.1.1
b) be undertaken by a suitably qualified ecologist approved by the Department in writing;	All ecological surveys will be undertaken by suitably qualified ecologists who are approved by the Commonwealth prior to the survey period
c) document the survey methodology, results and significant findings in relation to MNES;	This will be undertaken as part of the pre-clearance survey work
d) apply best practice site assessment and ecological survey methods appropriate for each listed threatened species, migratory species, their habitat and listed ecological communities	SSMP – Sections 4 to 6 Methodology to adopt Commonwealth guidelines, if not available State guidelines will be adopted



EPBC Conditions Relevant to the EM Plan	Section Addressed															
<p>7. Pre-clearance survey reports (which document the methods used and the results obtained) must be published by the proponent and provided to the Department on request.</p>	<p>Upon completion of the targeted surveys, a report detailing the survey methodologies and the field results will be provided to the relevant State and Commonwealth agencies and additionally published on the GLNG website as per approval conditions</p>															
<p><i>Disturbance limits</i></p>	<p>-</p>															
<p>11. The following maximum disturbance limits apply to any disturbances authorised for unavoidable impacts on listed threatened communities and potential habitat for listed threatened species or migratory species as a result of the construction, operation and decommissioning of the pipeline (and all associated activities).</p> <table border="1"> <caption>Table 1: EPBC Listed threatened ecological communities</caption> <thead> <tr> <th>Ecological community</th> <th>EPBC status</th> <th>Disturbance limit (ha)</th> </tr> </thead> <tbody> <tr> <td>Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant)</td> <td>Endangered</td> <td>4.4</td> </tr> <tr> <td>Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nadewar Bioregions</td> <td>Endangered</td> <td>2.4</td> </tr> <tr> <th>Species</th> <th>EPBC status</th> <th>Disturbance limit (ha)</th> </tr> <tr> <td><i>Cycas megacarpa</i> (Large-fruited Zamia)</td> <td>Endangered</td> <td>27.8</td> </tr> </tbody> </table> <p>Note: These conditions provide offsets for species identified in Table 1 except for Brigalow, for which offsets are provided in EPBC 2008/4059 (Santos/PETRONAS coal seam gas fields expansion).</p>	Ecological community	EPBC status	Disturbance limit (ha)	Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant)	Endangered	4.4	Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nadewar Bioregions	Endangered	2.4	Species	EPBC status	Disturbance limit (ha)	<i>Cycas megacarpa</i> (Large-fruited Zamia)	Endangered	27.8	<p>Chapter 9, SSMP</p>
Ecological community	EPBC status	Disturbance limit (ha)														
Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant)	Endangered	4.4														
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nadewar Bioregions	Endangered	2.4														
Species	EPBC status	Disturbance limit (ha)														
<i>Cycas megacarpa</i> (Large-fruited Zamia)	Endangered	27.8														



EPBC Conditions Relevant to the EM Plan	Section Addressed																						
<p>12. The proponent must prepare a management plan for each species in the table below. Each plan must be prepared in accordance with the requirements of condition 8.</p> <table border="1"> <thead> <tr> <th colspan="2">Table 2: Species management plans required before commencement</th> </tr> <tr> <th>Listed species</th> <th>EPBC Act Status</th> </tr> </thead> <tbody> <tr> <td><i>Philothea sporadica</i></td> <td>Vulnerable</td> </tr> <tr> <td><i>Cadellia pentasyllis</i> (Ooline)</td> <td>Vulnerable</td> </tr> <tr> <td><i>Paradelma orientalis</i> (Brigalow Scaly-foot)</td> <td>Vulnerable</td> </tr> <tr> <td><i>Furina dunmalli</i> (Dunmall's Snake)</td> <td>Vulnerable</td> </tr> <tr> <td><i>Egernia rugosa</i> (Yakka Skink)</td> <td>Vulnerable</td> </tr> <tr> <td><i>Geophaps scripta scripta</i> (Squatter pigeon – southern)</td> <td>Vulnerable</td> </tr> <tr> <td><i>Nyctophilus timoriensis</i> (Eastern Long-eared Bat)</td> <td>Vulnerable</td> </tr> <tr> <td><i>Chalinolobus dwyeri</i> (Large-eared Pied Bat)</td> <td>Vulnerable</td> </tr> <tr> <td><i>Xeromys myoides</i> (Water Mouse)</td> <td>Vulnerable</td> </tr> </tbody> </table> <p>Note: The intent of the table above is to require preparation of management plans for those species that are likely to be encountered along the ROW, but where a disturbance limit has not been quantified. To the extent that the requirements of condition 8 are satisfied for each species, a single Species Management Plan may be prepared for this purpose.</p>	Table 2: Species management plans required before commencement		Listed species	EPBC Act Status	<i>Philothea sporadica</i>	Vulnerable	<i>Cadellia pentasyllis</i> (Ooline)	Vulnerable	<i>Paradelma orientalis</i> (Brigalow Scaly-foot)	Vulnerable	<i>Furina dunmalli</i> (Dunmall's Snake)	Vulnerable	<i>Egernia rugosa</i> (Yakka Skink)	Vulnerable	<i>Geophaps scripta scripta</i> (Squatter pigeon – southern)	Vulnerable	<i>Nyctophilus timoriensis</i> (Eastern Long-eared Bat)	Vulnerable	<i>Chalinolobus dwyeri</i> (Large-eared Pied Bat)	Vulnerable	<i>Xeromys myoides</i> (Water Mouse)	Vulnerable	SSMP
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Listed species	EPBC Act Status																						
<i>Philothea sporadica</i>	Vulnerable																						
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<i>Chalinolobus dwyeri</i> (Large-eared Pied Bat)	Vulnerable																						
<i>Xeromys myoides</i> (Water Mouse)	Vulnerable																						
<p>14. Disturbance of vegetation related to the construction and maintenance of the pipeline must be confined to the ROW. Any proposed siting of construction camps, vehicle access tracks and pipe lay-down areas outside the ROW during construction must be undertaken so as to minimise potential adverse impacts on MNES and must comply with conditions 5 to 13.</p>	Chapter 9, Table 9.16, Sub-heading - Vegetation clearing																						



EPBC Conditions Relevant to the EM Plan	Section Addressed
<i>Cycas megacarpa</i>	-
23. To offset the unavoidable impacts to <i>Cycas megacarpa</i> from all activities associated with this approval, the proponent must, if the baseline route through the Callide and Calliope Ranges assessed in the EIS is pursued:	-
a) within 12 months of the date of this approval, secure an area of at least 166.8ha as an offset for receiving no less than 3990 translocated and propagated individuals;	Appendix A of SSMP
b) identify alternative recruitment methods if it is considered unlikely that translocation and propagation will be successful;	Appendix A of SSMP
c) notify the Department in writing of the acquisition or transfer of ownership of the area identified in Condition 23(a) within one month of securing the land;	Appendix A of SSMP
d) if the proponent proposes any action within a proposed offset area, other than actions related to managing that area as an offset property, approval must be obtained, in writing from the Department. In seeking Departmental approval the proponent must provide a detailed assessment of the proposed action including a map identifying where the action is proposed to take place and an assessment of all associated adverse impacts on MNES. If the Department agrees to the action within the proposed offset site, the area identified for the action must be excised from the proposed offset and alternative offsets secured of equal or greater environmental value in relation to the impacted MNES;	
e) demonstrate that the measures for securing and managing the offset will ensure that the offset is protected in perpetuity.	Appendix A of SSMP
<i>Cycas megacarpa Management Plan</i>	-
24. The proponent must prepare a <i>Cycas megacarpa</i> Management Plan in consultation with an expert approved by the Department in writing.	Appendix A of SSMP
25. The <i>Cycas megacarpa</i> Management Plan must include:	-
a) confirmation of the pipeline route across the Callide Range	Appendix A of SSMP
b) measures to ensure all <i>Cycas megacarpa</i> within the ROW are avoided using, for example suitable trenchless technique(s) as necessary or, if avoidance is not possible, individual plants must be removed and kept offsite and replanted in the same location, or alternatively translocated. Where it can be demonstrated that removal and translocation of individuals is unlikely to succeed, translocation may be substituted by establishing propagated individuals;	Appendix A of SSMP
c) measures to propagate and plant <i>Cycas megacarpa</i> individuals removed or impacted by construction activities to maintain a population of no less than 3990 (2610 if the CRAR is pursued) individuals within the offset site required by Condition 23(a);	Appendix A of SSMP
d) a detailed methodology for translocation, propagation, and planting, including a map of the location of the offset site;	Appendix A of SSMP



EPBC Conditions Relevant to the EM Plan	Section Addressed
e) details of funding required to secure, maintain and enhance the values of the offset site in perpetuity;	Appendix A of SSMP. Following is noted: Construction contractor will be responsible for ensuring maintenance and management of translocated cycads. These commitments will be bound contractually and the Project will be priced accordingly
f) details of a suitably qualified person to undertake translocation, propagation and planting;	Appendix A of SSMP
g) details of the erosion and sediment control measures to be implemented in the ROW in the Callide and Calliope Ranges;	Chapter 7. Sediment and Erosion Control Plan (SECP) (Appendix A)
h) measures to rehabilitate the RoW in the Callide and Calliope Ranges;	Chapter 15. SSMP. LRMP (Appendix G)
i) measures for the control and management of weeds, fire, feral animals, access and grazing in translocation sites;	Appendix A of SSMP. PWMP (Appendix D)
j) measures for the management, maintenance and protection of the population of <i>Cycas megacarpa</i> individuals in the offset site for a period of five years following final planting;	Appendix A of SSMP
k) details of monitoring practices to assess the success of proposed management regimes of the offset	Appendix A of SSMP
l) performance measures, reporting requirements, trigger levels for corrective actions and identification of those actions to be taken to ensure performance measures are met; and	Appendix A of SSMP
m) a reconciliation statement of impacts against the agreed limit of disturbance, as defined above in condition 11 must be updated by the proponent every 12 months from commencement until construction is complete.	Appendix A of SSMP
26. The <i>Cycas megacarpa</i> Management Plan must be submitted for the approval of the Minister. Commencement in the location covered by the management plan must not occur without approval. The approved plan must be implemented.	Appendix A of SSMP
<i>Location of pipeline (Callide range)</i>	-
34. East of the Callide Range, the proponent must locate the pipeline within the Callide Infrastructure Corridor State Development Area as indicated in the map at Attachment 1.	Chapter 1
<i>Water Crossings</i>	-
35. Where reasonably possible horizontal directional drilling must be used for major waterway crossings, including:	-
a) those within the Fitzroy and Calliope River catchments and any water crossing within the known distribution of the Fitzroy River Turtle (<i>Rheodytes leukops</i>) and Murray Cod (<i>Maccullochella peelii</i>). Pipeline construction across waterways must not take place during the nesting and breeding season of the Fitzroy River Turtle;	To be confirmed during design stage
b) Humpie and Targinie Creeks before marshlands near Kangaroo Island and The Narrows	To be confirmed during design stage



EPBC Conditions Relevant to the EM Plan	Section Addressed
36. Trenchless techniques are not required in minor creek beds within the known distribution of the Fitzroy River Turtle (<i>Rheodytes leukops</i>) and Murray Cod (<i>Maccullochella peelii peelii</i>) where there is no water at the crossing site and the distance to the nearest water is sufficient to buffer any potential impacts resulting from the crossing technique.	Noted
37. The proponent must prepare an Aquatic Values Management Plan. This plan must include:	-
a) a detailed assessment of aquatic values, including animal breeding locations for listed threatened and migratory species within the ROW;	SSMP This will be detailed in the Aquatic Values Management Plan (AVMP), which will be provided prior to construction
b) measures to minimise impacts on listed riparian, aquatic and water dependent flora and fauna;	This will be detailed in the AVMP, which will be provided prior to construction
c) measures to minimise erosion and sediment impacts to waterways;	ESCP (Appendix A) This will be detailed in the AVMP, which will be provided prior to construction
d) measures to maintain water quality and water flow requirements, including treatment and disposal methods for hydrostatic test water;	Chapter 14 This will be detailed in the AVMP, which will be provided prior to construction
e) site-specific mitigation measures for any potential impacts from construction and operation of the pipeline on listed threatened species, including but not limited to the Fitzroy River Turtle.	SSMP
f) The Aquatic Values Management Plan must be approved in writing by the Minister. Activities the subject of the plan must not start without approval. The Plan must be implemented.	Noted
<i>Auditing</i>	-
52. On the request of and within a period specified by the Department, the proponent must ensure that:	-
a) an independent audit of compliance with these conditions is conducted; and	Chapter 3, Section 3.7
b) an audit report, which addresses the audit criteria to the satisfaction of the Department, is published on the Internet and submitted to the Department.	Chapter 3, Section 3.7
53. Before the audit begins, the following must be approved by the Department:	-
a) the independent auditor; and	Chapter 3, Section 3.7
b) the audit criteria.	Chapter 3, Section 3.7
54. The audit report must include:	-



EPBC Conditions Relevant to the EM Plan	Section Addressed
a) the components of the project being audited;	Chapter 3, Section 3.7
b) the conditions that were activated during the period covered by the audit;	Chapter 3, Section 3.7
c) a compliance/non-compliance table;	Chapter 3, Section 3.7
d) a description of the evidence to support audit findings of compliance or non-compliance;	Chapter 3, Section 3.7
e) recommendations on any non-compliance or other matter to improve compliance;	Chapter 3, Section 3.7
f) a response by the proponent to the recommendations in the report (or, if the proponent does not respond within 20 business days of a request to do so by the auditor, a statement by the auditor to that effect);	Chapter 3, Section 3.7
g) certification by the independent auditor of the findings of the audit report.	Chapter 3, Section 3.7
55. The financial cost of the audit will be borne by the proponent.	
56. The proponent must:	-
a) implement any recommendations in the audit report, as directed in writing by the Department after consultation with the proponent;	Chapter 3, Section 3.7
b) investigate any non-compliance identified in the audit report; and	Chapter 3, Section 3.7
c) if non-compliance is identified in the audit report - take action as soon as practicable to ensure compliance with these conditions.	Chapter 3, Section 3.7
57. If the audit report identifies any non-compliance with the conditions, within 20 business days after the audit report is submitted to the Department the proponent must provide written advice to the Minister setting out the:	-
a) actions taken by the proponent to ensure compliance with these conditions; and	Chapter 3, Section 3.7
b) actions taken to prevent a recurrence of any non-compliance, or implement any other recommendation to improve compliance, identified in the audit report.	Chapter 3, Section 3.7
Note: To avoid doubt, independent third party auditing may include audit of the proponent's performance against the requirements of any plan required under these conditions.	
<i>Reporting non-compliance</i>	-
58. The proponent must, when first becoming aware of a non-compliance with these conditions, or a plan required to be approved by the Minister under these conditions:	-
a) report the non-compliance and remedial action to the Department within five business days;	Chapter 3, Section 3.7
b) bring the matter into compliance within a reasonable time frame specified in writing by the Department.	Chapter 3, Section 3.7
<i>Record keeping</i>	-



EPBC Conditions Relevant to the EM Plan	Section Addressed
59. The proponent must:	-
a) maintain accurate records substantiating all activities associated with or relevant to these conditions of approval, including measures taken to implement a plan approved under these conditions; and	Chapter 3, Section 3.7
b) make those records available on request to the Department. Such records may be subject to audit by the Department or an independent auditor in accordance with section 458 of the EPBC Act, or used to verify compliance with these conditions. Note: Audits or summaries of audits carried out under these conditions, or under section 458 of the EPBC Act, may be posted on the Department's website. The results of such audits may also be publicised through the general media.	Chapter 3, Section 3.7
<i>Financial assurance</i>	-
60. The proponent must:	-
a) provide the Minister with a financial assurance in the amount and form required from time to time by the Minister for activities to which these conditions apply; and	Chapter 4
b) review and maintain the amount of financial assurance based on proponent reporting on compliance with these conditions, and any auditing of the activities.	Chapter 4
61. The financial assurance is to remain in force until the Minister is satisfied that no claim is likely to be made on the assurance. Note: The financial assurance may be used for rehabilitation of habitat and other purposes not addressed adequately by the proponent during the life of the project.	Chapter 4
<i>Annual environmental return</i>	-
62. The proponent must produce an Annual Environmental Return which:	-
a) addresses compliance with these conditions;	Chapter 3, Section 3.7
b) records any unavoidable adverse impacts on MNES, mitigation measures applied to avoid adverse impacts on MNES; and any rehabilitation work undertaken in connection with any unavoidable adverse impact on MNES;	Chapter 3, Section 3.7
c) identifies all non-compliances with these conditions; and	Chapter 3, Section 3.7
d) identifies any amendments needed to plans to achieve compliance with these conditions.	Chapter 3, Section 3.7
63. The proponent must publish the Annual Environmental Return on its website within 20 calendar days of each anniversary date of this approval. In complying with this publication requirement, the proponent must ensure that it has obtained relevant rights in relation to confidentiality and intellectual property rights of third parties	Chapter 3, Section 3.7
64. If requested by the Department, the proponent must provide all species and ecological survey data and related survey information from ecological surveys undertaken for MNES. The data must be collected and recorded to conform to data standards notified from time to time by the Department	Chapter 3, Section 3.6

2. Project description

This EM Plan is for the Mainland section of the GTP which runs from the gas fields at Fairview to the start point of the Marine Crossing EM Plan on Port Curtis, traversing a distance of approximately 406 km. Further details regarding this section of the Project along with a detailed construction methodology are provided throughout the remainder of this chapter.

2.1 Project justification

2.1.1 International demand

World energy demand continues to rise. Between 2008 and 2030, energy demand is expected to increase by 45%, an annual average rate of increase of 1.6% (International Energy Agency, 2008). Simultaneously, there is increased pressure to find less carbon-intensive energy solutions in an increasingly carbon-constrained world. The Project is a less carbon-intensive energy solution than other fossil fuel alternatives. As such, the Project can be a global contributor to energy needs with reduced greenhouse gas outputs.

In the calendar year 2007, Australia exported 15.2 million tonnes of LNG, valued at \$5,368 million (ABARE, 2008). Exports of LNG have increased strongly over the past 20 years, and have risen particularly rapidly over the past five years. Exports of approximately 25 million tonnes are predicted for 2011 to 2012.

ABARE (2008) predicts that this growth in exports will continue, with natural gas exports expected to grow by almost 8% per year until 2030. Most of this growth is expected to come from increased production from the North West Shelf project and the ConocoPhillips LNG plant in Darwin, supplying LNG to Japan. More West Australian operations are in the development phase, including Gorgon and Pluto projects in the Carnarvon Basin, and several in the Browse Basin.

The majority of the world's large importers of LNG are in the Asia Pacific region, giving Australia a natural advantage in terms of the relatively short distances to these key markets. In 2007 Australia exported over 20 billion m³ of gas mainly to Japan and China.

ABARE (2008) predicts that the international demand from LNG importing countries will continue. This is expected to be 120 million tonnes in 2010 and increasing to over 150 million tonnes by 2015. There is a clear opportunity for the Project to fill some of this need.

2.1.2 Domestic demand

Within Australia, increasing demand for natural gas is likely to change the market structure in coming years. At present there are a small number of producers and a small number of large consumers, with relatively low household consumption. In 2007 there were approximately 3.75 million households in Australia using natural gas, most supplied by low pressure gas pipelines (ABARE, 2008).

Domestic consumption of natural gas is predicted to nearly double by 2030 (ABARE, 2008). This increase is due to increased demand for natural gas in electricity generation, manufacturing and mining, partly as a result of government policy incentives such as the Queensland 13% Gas Scheme. Under this scheme electricity retailers are required to source 13% of the electricity they sell in Queensland from gas-fired generation. The target will increase to 18% by 2020. The scheme is designed to diversify Queensland's energy mix towards the greater use of gas, assist in encouraging the development of new gas sources and infrastructure in Queensland, and reduce greenhouse gas emissions from the Queensland electricity sector.



In 2005-06, natural gas accounted for 565 PJ of Australia's domestic energy consumption, or around 16% of total consumption. This is projected to increase to 18% by 2029-30.

Santos made a comprehensive, commercial-in-confidence submission to the *Queensland Government LNG Industry Issues Paper* on 17 December 2008 in which Santos addressed the question of expected impacts of LNG on domestic gas and electricity prices. This information has also been provided to the Government EIS assessment team to ensure the Project is fully compliant with the EIS terms of reference.

2.2 Mainland GTP alignment

The Mainland GTP forms a part of the proposed GTP, which runs from the CSG fields in Fairview to the LNG Facility on Curtis Island, and covers a distance of approximately 420 km. The Mainland GTP itself will extend from the gas fields at Fairview to Point A at Port Curtis (see Figure 1.1), traversing a distance of approximately 406 km.

2.2.1 Route alignment process

The criteria used to determine the most appropriate route for the GTP were based on the Australian Pipeline Industry Association's *Code of Environmental Practice (2009)* (APIA Code (2009) and Australian Standard AS 2885.1 – 2007 Pipelines – Gas and Liquid Petroleum (AS 2885). The criteria used in the route selection process are outlined in Table 2.1.

Table 2.1 Criteria for route selection

Issue	Criteria
Land use	Minimise access through populated areas and rural houses
	Parallel property boundaries adjacent to fence line where possible, rather than dissecting lots
	Minimise crossing specialist agricultural blocks (ie irrigated areas, contoured land)
	Minimise number of landowners affected and avoid small rural lots
Environmental	Avoid sites of known cultural heritage significance
	Protection of landscape values
	Avoiding ecosystems of conservation significance and essential habitats
	Minimise impacts of vegetation clearing where avoidable
	Cross watercourses at 90° to flow
	Avoid crossing watercourses at bends, to prevent erosion of disturbed land
	Minimise impacts on riparian vegetation, by crossing at disturbed areas
	Avoid wetlands
Ensure environmental sustainability	
Co-use of easements	Road easements can be utilised, but not all easements will be able to cater for a 30 m RoW. Generally, road easements contain services which can threaten pipeline integrity
	Pipeline easements can be used
	Power line easements can be used; however, additional design costs apply
	Railway easements are not ideal, unless significant space available
	Cross roads, highways, railways and other services at 90° where practical and safe
Safety	Relevant safety standards
	Assessment of safety risks
Commercial	Present market requirements

Issue	Criteria
	Construction and operating costs
Engineering	Relevant construction and operation standards
	Construction access requirements
	Terrain and geotechnical constraints
Physical constraints	Avoid side slope (ie paralleling contours on a hill)
	It is preferential to run with slope (ie cross contours at 90°)
	Avoid escarpments – unless conducting Horizontal Directional Drilling (HDD)
	Avoid unstable soils and erosion prone areas

2.2.2 Alternate Mainland GTP routes

As a result of the route selection process described above, the following three (3) alternative GTP route options were considered:

Option 1

Option 1 - an alignment that is generally adjacent to the existing Queensland Gas Pipeline (QGP), running north of Injune and then east to the coast.

Option 2

Option 2 - a direct corridor from the Fairview CSG fields running northeast to Gladstone. This alternative route is 380 km long and passes around the southern end of Expedition National Park and traverses across to the south of the Palm Tree and Robinson Creeks wetland system, 28 km north of Taroom. From here the most suitable route runs between Precipice National Park and the Anglo Coal (Theodore South) Mineral Development License area, although this presents a highly constrained solution in this area. The remainder of the route running north east to Gladstone is relatively unconstrained.

Option 3

Option 3 - an alignment similar to option 2; however this route has a more northern-easterly alignment such that it proceeds to Dawson Valley. From the Dawson Valley it follows Option 1.

Based on the selection criteria listed in Table 2.1, Option 1 was selected as the preferred route. Further details regarding this route are presented in Section 2.2.3.

2.2.3 Alignment of the Mainland GTP

The Mainland GTP will extend from the gas fields at Fairview through to Port Curtis, a distance of approximately 406 km. Figure 1.1 illustrates the route and provides co-ordinates at the start and end points.



From the gas fields at Fairview, the Mainland GTP will traverse mostly rural land and numerous ranges. It is closely aligned with the existing QGP for much of its length with the exception of the section north of Injune. The route departs Fairview in a northerly direction continuing north through the Arcadia Valley. It then turns east and crosses the Expedition Range, the Dawson Range and then a wide section of the Dawson River. The GTP continues in an easterly direction, crossing the Callide and Calliope Ranges (within the Callide Infrastructure Corridor State Development Area). It will approach Gladstone from the southwest and pass through the Gladstone State Development Area (GSDA). After crossing the Calliope Range, the GTP crosses the Bruce Highway and terminates on Port Curtis (Long. 151.115151, Lat -23.750982) as illustrated in Figure 1.1. From Port Curtis, the GTP then traverses an intertidal and marine environment (referred to as the Marine Crossing GTP) and then south through Curtis Island (see Curtis Island EM Plan) where it terminates at the LNG facility on Curtis Island.

Locating the Mainland GTP adjacent to the existing Jemena owned QGP RoW for approximately 300 km of the corridor from south of Rolleston to Gladstone reduces the area of land disturbance and impacts on existing land use and infrastructure. It should be noted that land use, environmental and topographical constraints have resulted in deviations from the QGP route along some sections of the Mainland GTP.

2.3 Project timing and life

For the first stage of the GLNG Project the CSG fields are expected to produce approximately 5,300 petajoules (PJ) (140 billion m³) to supply to the LNG facility. This will involve the development of approximately 2,650 exploration and production wells. It is anticipated that approximately 1,200 wells will be established prior to 2015, with the potential for a further 1,450 or more additional wells to be established thereafter. Additional supporting infrastructure including field gathering lines, nodal compressor stations, centralised compression and water treatment facilities, accommodation facilities, power generation and water management facilities will also be installed.

The LNG facility is to be developed in three stages. Each stage is termed a 'train'. Construction of the first train (Train 1) including the marine facilities and capital dredging is proposed to commence in 2011 with construction taking approximately 4 years with a projected completion date of December 2014.

The LNG facility operations are planned to commence in early 2015. Construction of Train 2 will commence as early as 2012, which will bring the LNG facility up to its ultimate capacity of 10 Mtpa. However the timing of these trains is dependent on market conditions, gas availability, labour availability and the economic climate. It is possible that construction of Trains 1 and 2 may overlap.

During this time, development of the CSG fields will be on going, up to the 5,300 PJ production rate required for Train 1. As each production well will have an approximate life of 5 to 15 years it will be necessary to replace depleted wells with new ones. New wells will be developed at a rate that is sufficient to provide enough CSG for the annual LNG production.

The design life and the operational life of the Mainland GTP is 42 years. The proposed project schedule is provided in Table 2.2. Operations of all project components will continue past the year 2022 that is shown in this Table.

Table 2.2 Project Schedule

Stage	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
CSG Fields														
Construction														
Operation														
Gas Transmission Pipeline														
Construction														
Operation														
LNG facility														
Train 1														
Construction														
Operation														
Train 2														
Construction														
Operation														

2.4 Design standards of the Mainland GTP

The Mainland GTP will be constructed using open cut trenching. The pipeline will cross minor watercourses using conventional crossing techniques, including HDD where appropriate and feasible.

The pipeline will be designed and constructed in accordance with AS 2885.1 – 2007 Pipelines – Gas and Liquid Petroleum as well as other applicable standards and regulations, including the Australian Pipeline Industry Association (APIA 2009) *Code of Environmental Practice*.

Key engineering and design features of the Mainland GTP are provided in Table 2.3.

Table 2.3 Mainland GTP specifications

Design element	Details
Type of petroleum activity	Gas transmission pipeline (GTP)
Approximate length	410 km
Maximum diameter	1,050 mm
Wall thickness	14.1 mm, 15.0 mm (standard); 17.9 mm, 19.7 mm (heavy walled)
Line pipe specification	API 5L X70 PSL2
Pipe manufacturing type	Submerged Arc Welded-Helical (SAWH)
Factory-applied external coating	Double layer Fusion-bonded Epoxy (FBE) coating
Factory-applied internal lining	Two-part liquid epoxy
Pipeline medium	Sales quality gas
Operational pressure	10.2 MPa
Maximum allowable operating pressure (MAOP)	10.2 MPa
Specified minimum yield stress	485 MPa
Standard construction RoW width	40 m (narrowed to 30 m in sensitive areas)
Easement width	30 m with a 10 m working area. In areas allocated as infrastructure corridors, the RoW is 50 m

Design element	Details
Planned Project life – design and operation	Approximately 42 years
Minimum depth of cover	In accordance with AS 2885.1, typically ranging from 750 mm (R1) to 900 mm (T1) and up to 2000 mm for other locations such as road, rail, river crossing and high consequence areas
Corrosion protection	External coating and impressed current cathodic protection
Non-destructive testing	100% radiography or ultrasonic testing of welded joints. Hydrostatic pressure testing of completed pipeline to 125 % of MAOP as per AS2885 requirement
Pipeline monitoring system	SCADA system for remote monitoring and control of all facilities at each end of the pipeline such as flow rate, pressure, temperature, control main line valves and inlet/outlet valves
Main line valves	Main line valves will be located at intervals and used for isolating sections of the pipeline and venting gas to enable maintenance activities or isolation in the event of an incident
Scraper stations	Scraper stations will be installed on the GTP and will be used for inserting and removing in-line and inspection tools to assess condition of pipeline while maintaining pipeline in service
Area of disturbance	Approximately 1,575 ha
Number of wells	N/A
Hours of operation	Typically 11 hours a day, 6.30 am to 6.30 pm (with a one hour break), 7 days a week. Further details provided in Section 2.5
Annual production rates	N/A
Planned project life	Design – 42 years Operation – 42 years
Chapter 4 activities	See Section 2.9
Notifiable activities	See Section 2.10

The GTP RoW will be set out in accordance with the construction drawings as follows:

- Stated edges of RoW
- Stated pipeline centreline
- Locate and expose all buried infrastructure
- Locate and isolate protected flora and fauna in accordance with the Significant Species Management Plan (SSMP)

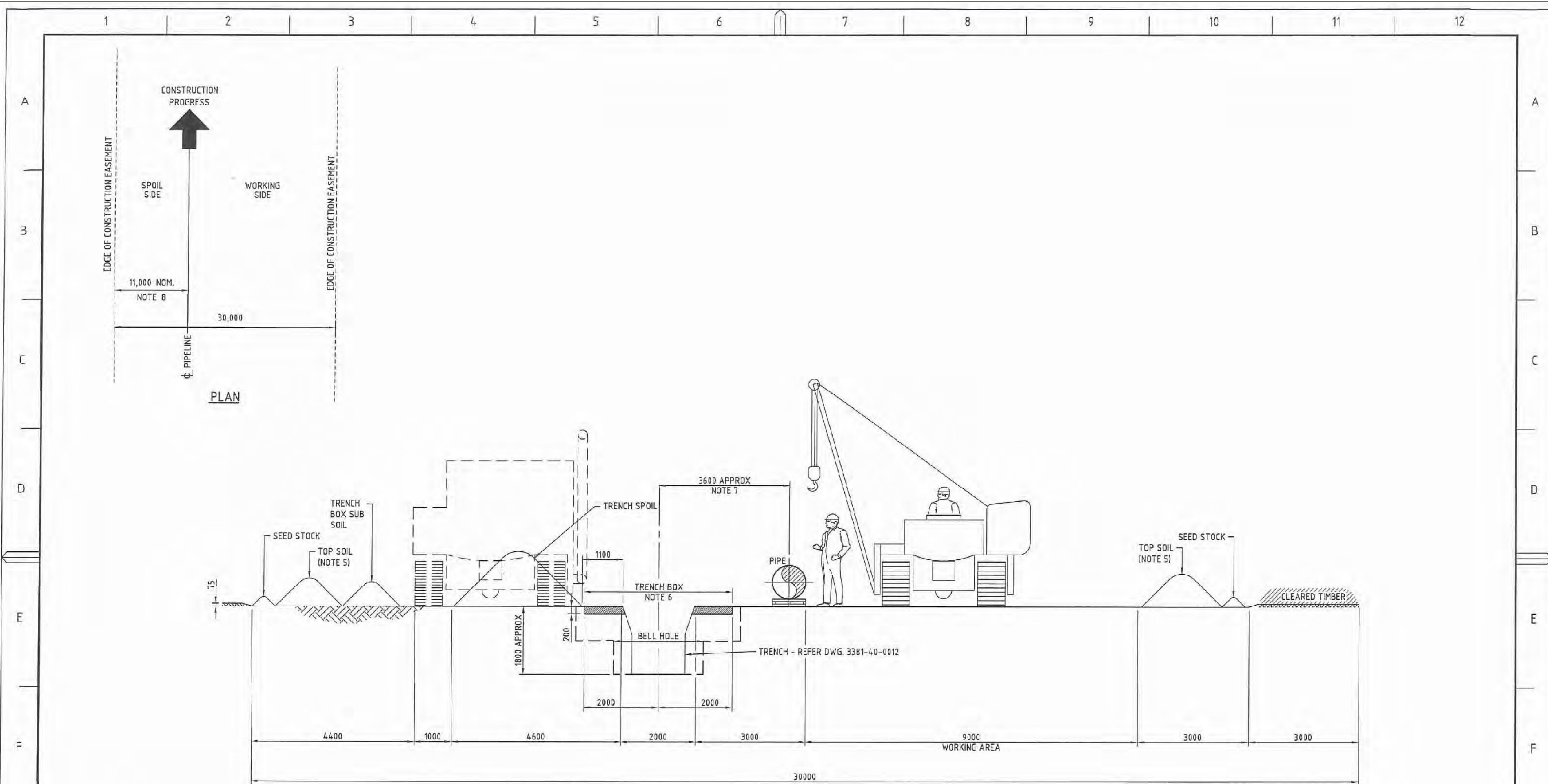
2.5 Mainland GTP construction

2.5.1 Clear and grade

Clear and grade will be carried out to provide an access for a construction RoW for plant, equipment and vehicular movement. The RoW for the Mainland GTP section will generally be 40 m wide (a 30 m easement with a 10 m work area), and narrowed to 30 m wide for areas defined as an Environmental Sensitive Area (ESA). A typical 30 m and 40 m RoW layout is presented in Figure 2.1 and Figure 2.2.

Clearing within the RoW will be in accordance with the SSMP. In the case of protected or retained vegetation within the RoW, the vegetation will be marked with coloured flagging or marker tape to indicate that it is to be avoided.

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Map by: SLG



30m RIGHT-OF-WAY CROSS SECTION
LOOKING IN DIRECTION OF CONSTRUCTION PROGRESS

- NOTES:**
1. DELETED
 2. DELETED
 3. MINIMUM SPACING OF 1m BETWEEN BOX TOPSOIL AND TRENCH SPOIL MUST BE MAINTAINED.
 4. BENCHING FOR TRENCH BOX TO BE DONE TO 200mm MAXIMUM DEPTH. REFER TO ALIGNMENT SHEETS FOR ROW WIDTH.
 5. TOP SOIL FROM ENTIRE ROW IF REQUIRED TO BE REMOVED. REFER TO CONSTRUCTION SPECIFICATION.
 6. TRENCH AND BOX DIMENSIONS MAY BE VARIED WITH GLNG APPROVAL IF EXCAVATORS/BLASTING IS USED.
 7. DIMENSION ON HOLD PENDING ADVICE ON GLNG REQUIREMENT TO WELD BEFORE TRENCHING.
 8. MAY VARY IN ORDER TO FIT PIPE INTO EASEMENT AT BEND LOCATION.
 9. DELETED
 10. FLAG BOUNDARIES PRIOR TO GRADING AND CLEARING. ADDITIONAL FLAGGING MAY BE REQUIRED AT ENVIRONMENTALLY SENSITIVE AREAS eg. WETLANDS.
 11. RIGHT OF WAY DETAIL TO BE HEAVILY REVISED FOR WATERWAY / WETLAND CROSSINGS AND OTHER SENSITIVE AREAS.

PRELIMINARY



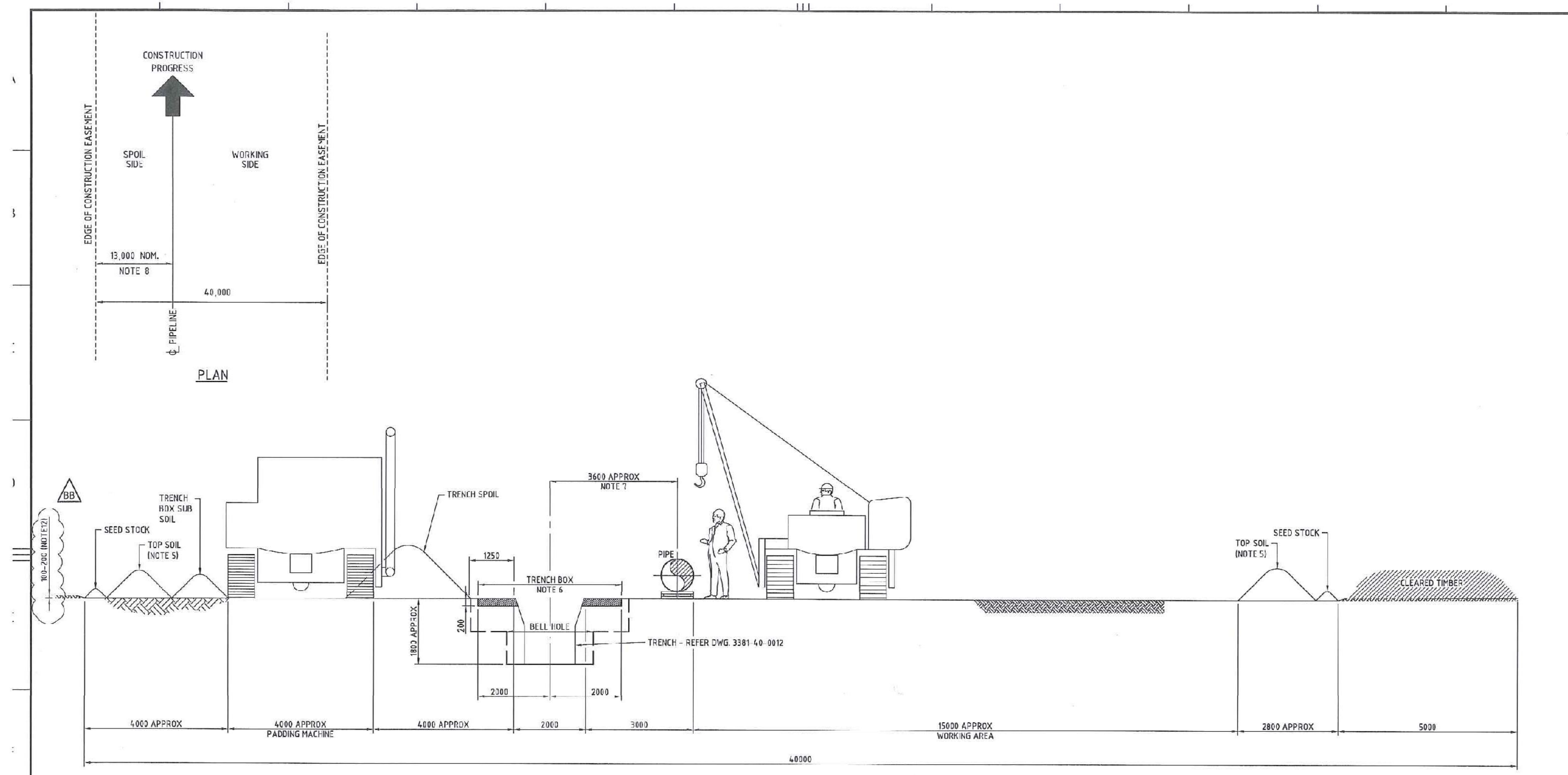
No	DATE	DRN	CHKD	ENG	Q.A.	PRGJ	ACC	DESCRIPTION	DRS No.	SUBJECT	REFERENCE DRAWINGS
AA	19/11/09	GHD						ISSUED FOR APPROVAL - 42 INCH			
A1	29/10/09	GHD	CEJ			TM		ISSUED FOR INTERNAL REVIEW			

DRN:	GHD
DATE:	23/10/09
SCALE:	NTS
CHKD:	
ENG:	
D.A.:	
PROJ:	
ACC:	
A.B.N.	80 007 550 923

GLNG GAS PIPELINE
30m RIGHT-OF-WAY LAYOUT
PIPELINE STANDARD

DRAWING No:	3381-40-0151	REV	AA
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4.0m RIGHT-OF-WAY CROSS SECTION
LOOKING IN DIRECTION OF CONSTRUCTION PROGRESS

NOTES:

1. DELETED
2. REFER TO 3381-GHD-3-3.3-0185 FOR TOPSOIL REMOVAL.
3. MINIMUM SPACING 90mm BETWEEN BOX TOPS AND TRENCH SPOIL MUST BE MAINTAINED.
4. BENCHING FOR TRENCH BOX TO BE DONE TO 200mm MAXIMUM DEPTH. REFER TO ALIGNMENT SHEETS FOR ROW WIDTH.
5. TOP SOIL FROM ENTIRE ROW IF REQUIRED TO BE REMOVED. REFER TO CONSTRUCTION SPECIFICATION.
6. TRENCH AND BOX DIMENSIONS MAY BE VARIED WITH GLNG APPROVAL IF EXCAVATORS/BLASTING IS USED.
7. DIMENSION ON HOLD PENDING ADVICE ON GLNG REQUIREMENT TO WELD BEFORE TRENCHING.
8. MAY VARY IN ORDER TO FIT PIPE INTO EASEMENT AT BEND LOCATION.
9. DELETED
10. FLAG BOUNDARIES PRIOR TO GRADING AND CLEARING. ADDITIONAL FLAGGING MAY BE REQUIRED AT ENVIRONMENTALLY SENSITIVE AREAS eg. WETLANDS.
11. RIGHT OF WAY DETAIL TO BE HEAVILY REVISED FOR WATERWAY / WETLAND CROSSINGS AND OTHER SENSITIVE AREAS.



No	DATE	DRN	CHKD	ENG	Q.A.	PROJ	ACC	DESCRIPTION	DRG No.	SUBJECT	REFERENCE DRAWINGS
BB	30/09/10							GLNG ISSUED FOR DETAILED DESIGN			
AA	19/11/09	GHD	CEJ	TM				ISSUED FOR APPROVAL - 42 INCH			
C	29/10/09	GHD	CEJ	TM				PADDER ADDED			
B	27.08.09	GHD						ISSUED FOR GLNG REVIEW			
A1	24.05.09	GHD						ISSUED FOR INTERNAL REVIEW			

PRELIMINARY

**GLNG GAS PIPELINE
40m RIGHT-OF-WAY LAYOUT
PIPELINE STANDARD**

DRN: GHD	DATE: 24/06/09
SCALE: NTS	
CHKD:	
ENG:	
Q.A.:	
PROJ:	
ACC:	
A.B.N. 83 697 559 923	

DRAWING No. **3381-40-0050** REV **BB**

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The plant and equipment to clear and level the RoW is listed below. Clearing of the RoW shall include the removal as required of trees, brush, stumps and other obstacles, and the grubbing, or removal otherwise, of stumps in the way of the trench line and in trafficked areas. Cut timber and other vegetation shall be stockpiled along the edges and within the RoW. Selected trees, timber and vegetation cleared and stockpiled on the working side of the RoW will be re-spread during rehabilitation to optimise re-growth and RoW reinstatement.

Existing water flows across the RoW will be maintained during clearing and grading, where necessary by the use of temporary drainage structures. All temporary drainage structures will be removed when no longer required. All grading works will be undertaken in accordance with the requirements stipulated in the Erosion and Sediment Control Plan (ESCP) (refer Appendix A).

Topsoil will be stripped from the RoW to a depth not more than 200 mm, and will generally be undertaken to ensure the following:

- Topsoil will be removed from the trench line and trafficked areas, and stockpiled as windrows along the edge of the RoW, where topsoil has not been previously stripped
- Topsoil stockpiles shall not be placed within drainage lines
- Proper openings in trench spoil banks will be provided to allow normal drainage of the area and to prevent surface water from ponding
- Topsoil will not be placed up against trees

Topsoil stripped from access tracks within the RoW will be stockpiled for reinstatement. Subsoil from the levelling of the RoW will be stockpiled separately from vegetation and topsoil. It will be placed to assist with restoring original contours. In rock areas surplus excavated rock material and surface boulders within the RoW will be stockpiled separately.

Timing of clearing and grading

The timing of clearing and grading will be in accordance with the construction schedule, and will be undertaken 7 days per week 11 hours per day, from 6.30 am to 6.30 pm (including a one hour break)

Proposed plant and equipment

The plant and equipment proposed for the clearing and grading are listed below:

- Excavators
- Front end loaders
- Dozers
- Mulchers
- Graders
- Water tankers
- Vibrating rollers
- Trucks
- Vacuum lifter

2.5.2 Stringing and bending

Pipe stringing involves laying the pipe out in lengths in preparation for welding. Pipe will be transported to the Mainland GTP RoW to temporary pipe storage sites adjacent to the RoW on trucks (refer Figure 2.3 for location of temporary pipe storage sites and Section 2.5.12 for transport of pipe to the RoW).



Mainland GTP EM Plan

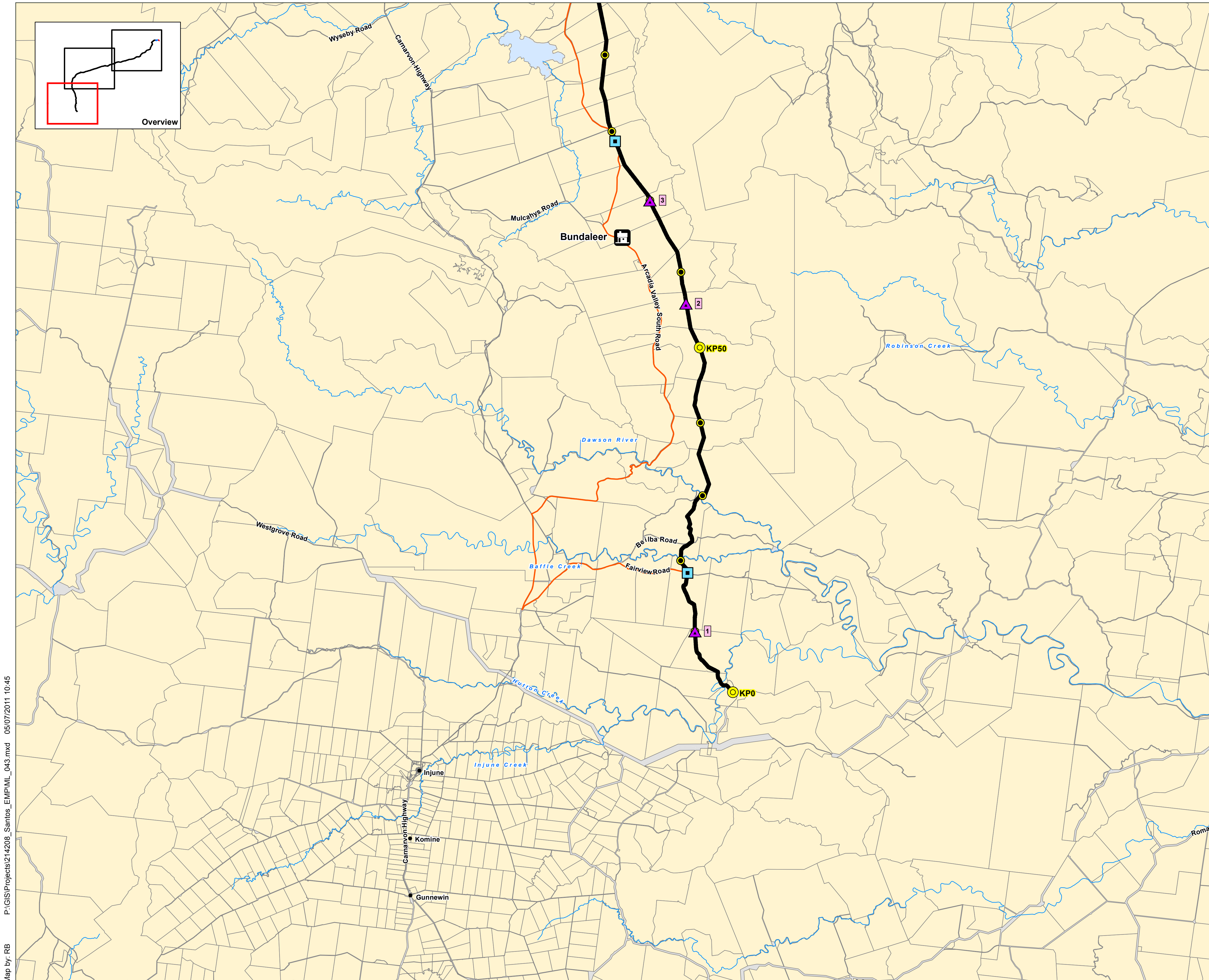
- Gas Transmission Pipeline (GTP)
 - Mainland GTP EM Plan
 - Marine Crossing GTP EM Plan
 - Curtis Island GTP EM Plan
- Kilometre Post Distance Marker
 - 50km
 - 10km
- Construction Camp
- Temporary Pipe Storage Site
- Vehicle Washdown and RoW Access Point (Indicative Location Only)
- Haulage Route
- Cadastral
- Rail
- Watercourse
- Major Road

Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Aerial: Santos, 2011.
 Cadastral: Department of Environment and Resource Management, Jun 2011.
 Temporary Pipe Storage Site: GLNG Pipeline Logistics Study, GHD, Nov 2009.
 Construction Camps: GLNG Pipeline Logistics Study, GHD, Nov 2009.

Key GTP Construction Infrastructure Figure 2.3 (Page 1 of 3)

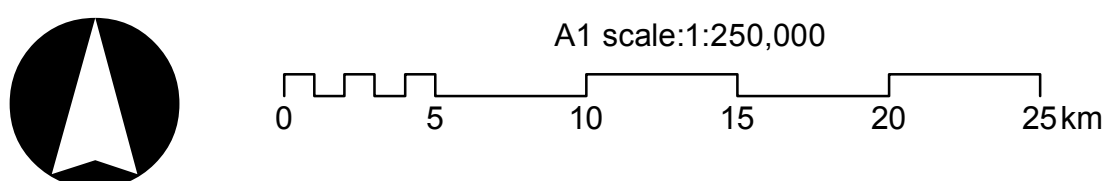
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 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

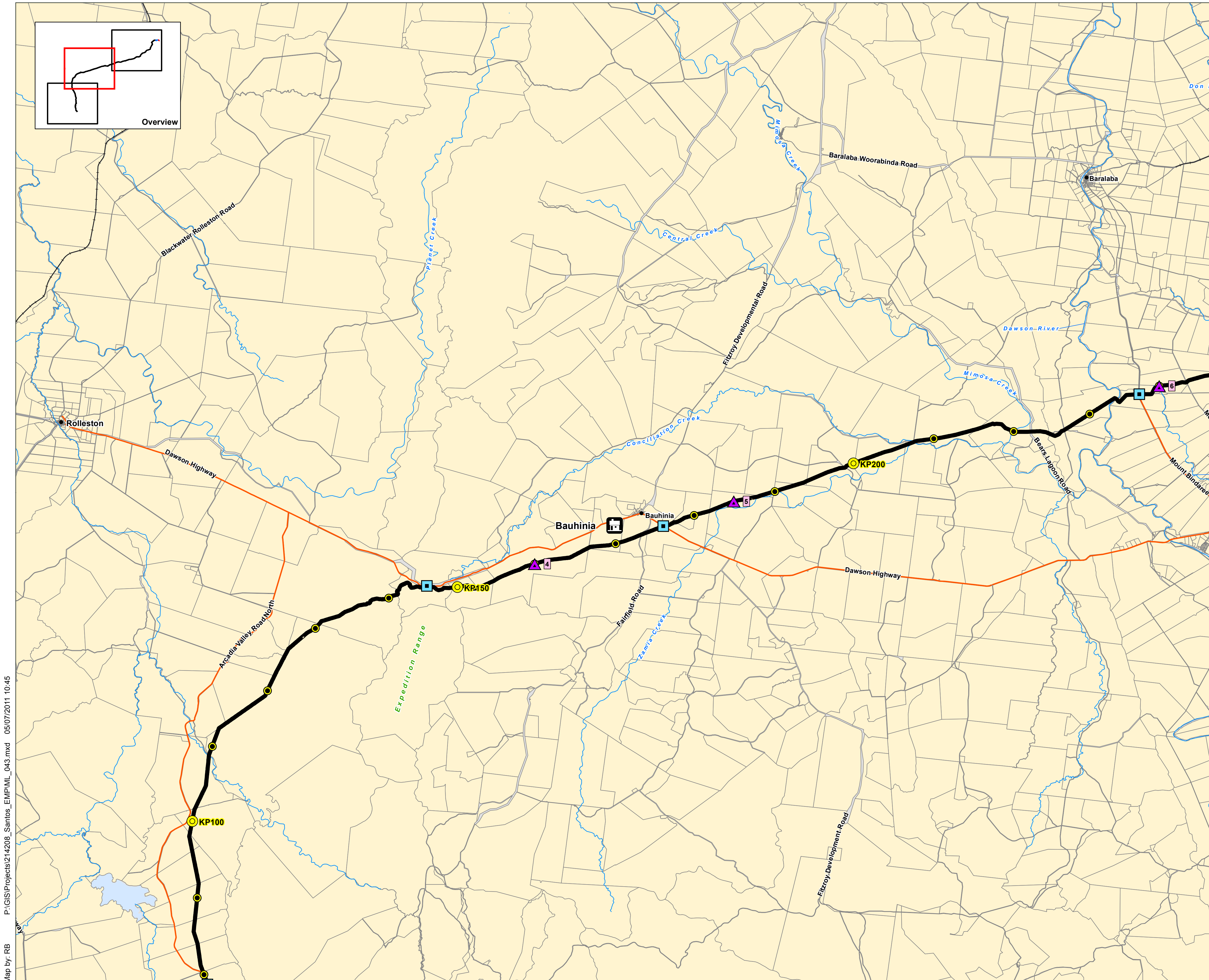
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Key GTP Construction Infrastructure Figure 2.3 (Page 2 of 3)

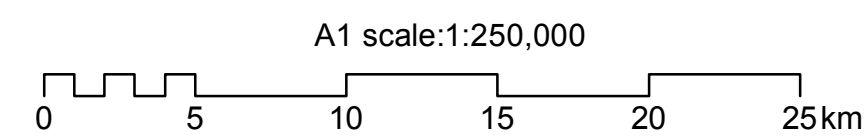
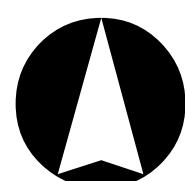
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Map by: RB



GLNG No: 3381-40-0404
 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

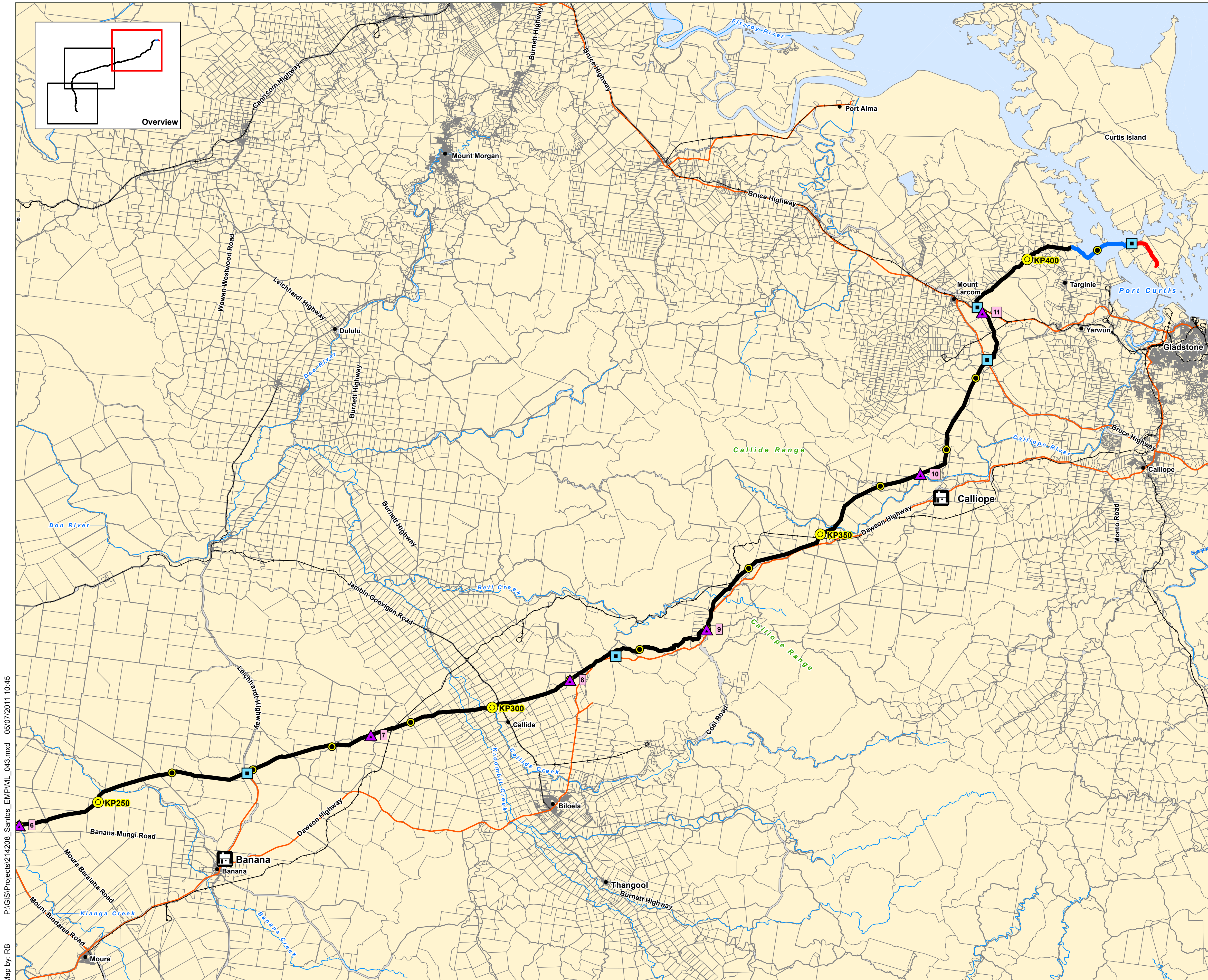
- Gas Transmission Pipeline (GTP)
 - Mainland GTP EM Plan
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Source:
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Key GTP Construction Infrastructure Figure 2.3 (Page 3 of 3)

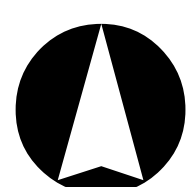
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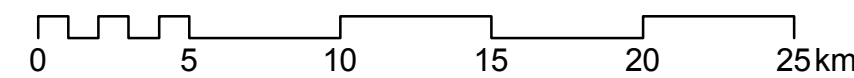


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GLNG No: 3381-40-0404

Coordinate system: GCS GDA 1994

The pipes will be placed on wooden skids in order to elevate the pipe from the ground surface, standing water and mud. Where required, pipe lengths are bent to match changes either in elevation or trench direction using a hydraulic bending machine.

Timing

Stringing and bending will be undertaken 7 days per week 11 hours per day, from 6.30 am to 6.30 pm (with a one hour break).

Proposed plant and equipment

The plant and equipment proposed for the pipeline stringing and bending operations are listed below:

- Excavators modified for string and bending operations
- Side-boom or crane with suitable rigging
- Spreader bar with guide lines at each end
- Bending machine

2.5.3 Welding and coating

Once the pipe is strung it will then be positioned using side boom tractors and clamped for welding. All separated, welded sections of the pipeline will be welded into a continuous length after lowering-in of the strings. Tie-in connections will be completed by special crews, fully equipped with all necessary cutting, bevelling and welding equipment. Following welding and non-destructive testing the weld joints will be cleaned by grit blasting and coated with speciality polymer coating (SP-2888 R.G. Brush Grade Base White).

Timing

Tie-ins will be undertaken 7 days per week 11 hours per day, from 6.30 am to 6.30 pm (with a one hour break).

Proposed plant and equipment

The plant and equipment proposed for welding and tie-in operations are listed below:

- Side-booms
- Pay welder sets
- Trucks equipped with working tools
- Diesel powered welding machines
- Holiday detectors
- Backhoe excavators
- Truck with propane
- Bevel cutting machine
- Generator

2.5.4 Trenching

Trenching will be undertaken either prior to, during or after pipe stringing, and will depend upon the project schedules, terrain and other logistical factors.

The trench shall be excavated to sufficient depth to assure the proper installation of the pipeline in accordance with AS 2885.1 and Table 2.3.

Trench spoil will be properly windrowed beside the trench allowing gaps at regular intervals for access tracks and for surface drainage. The amount of open trench will be restricted to that which is necessary for efficient completion of the work. If open trench distances are substantial, backfill will be required at intervals to form stock crossings and fauna exits from the trench.

All water in the bottom of the trench will be removed where practical and disposed of in accordance with the water management measures proposed in Chapter 14 and the ESCP (refer Appendix A) prior to lowering the pipe into the trench. Where Acid Sulfate Soils (ASS) are identified, discharge shall comply with the ASSMP presented in the Marine Crossing EM Plan.

Timing

Trenching will be undertaken 7 days per week 11 hours per day, from 6.30 am to 6.30 pm (with a one hour break).

Proposed plant and equipment

The plant and equipment proposed for trenching are listed below:

- Trenchers with either buckets or chain
- Excavators with rock hammers
- Traxcavator (combined excavator and track machine)
- Dumper trucks

2.5.5 Lowering and backfilling

Typically, the pipe shall be placed directly on the trench bottom without bedding beneath it. When trenching through areas where bedding is required (ie continuous rock or rock-bearing soil) then bedding, shading and padding shall be used. The pipe string will generally be located in the centre of the trench, away from trench walls.

Where it is intended to place bedding and shading/padding material in a single pass, the pipe will be supported from the invert of the trench using foam pillow, or if necessary, soil filled bags.

Trapped fauna will be removed from the trench prior to lowering-in. The pipe will be lowered into the trench using side-booms with roli-cradles.

The trench will be visually inspected before bedding, padding and backfilling operations commence.

Backfill soils will be compacted to a level consistent with surrounding soils, with the aim of minimizing trench subsidence.

The trench backfilling shall be compacted by rubber-tyred wheel rollers. Surplus excavated material will be spread across the RoW in accordance with the requirements of the ESCP (refer Appendix A).

Timing

Lowering and backfilling will be undertaken 7 days per week 11 hours per day, from 6.30 am to 6.30 pm (with a one hour break).

Proposed plant and equipment

The plant and equipment proposed for the lowering and backfilling operations are listed below:

- Side-booms
- Roli-cradles
- Holiday detector
- Excavator
- Front loaders
- Dewatering equipment
- Dozers
- Padding machine
- Trucks
- Rollers
- Water tankers

2.5.6 Hydrostatic testing, cleaning and commissioning

Hydrostatic testing

Pipe integrity is verified by hydrostatic testing which will be undertaken in accordance with a Hydrostatic Testing Management Plan (HTMP). This plan will be developed during the design phase by the Contractor prior to construction.

During hydrostatic testing (hydrotesting) the pipe will be filled with water sourced from nearby dams, rivers, bores or town supplies. The test water will be pumped into the pipeline. The location, source and amount of water supplied for testing will be determined prior to commencing construction during the design phase. The pipeline once capped and filled is then pressurised and a 24-hour leak test then follows. It is anticipated that hydrotesting will be of a potable quality water standard.

The management of the hydrotest water is in the Hydrotest Management Plan. This will be developed during the design stage before construction. The water from hydrotesting will be recycled from one test section to another with slight loss and make up. All hydrotesting water released to land will be tested and comply with discharge limits before being released to land (refer Chapter 14).

Cleaning and commissioning

After completion of hydrotesting the pipeline will be de-watered, cleaned and dried such that:

- All residual free water is removed and drained to land in accordance with the HTMP
- The pipeline section is substantially free of residual dust

Commissioning of the pipeline will be undertaken at the completion of hydrotesting and cleaning.

Timing

In the case of hydrotesting, cleaning and commissioning works, there is the potential for these to be undertaken on a 24 hour per day basis until the hydrotesting process is complete.

2.5.7 Crossings

Road crossing construction methods will be selected based on the road formation type. Crossing design and construction methods will vary according to road function, road design and the size and quantity of vehicles that use the road. The types of road crossing methods to be considered are summarised below, along with the relevant road types:

- Open cut: unformed and formed tracks, gravel roads and some bitumen roads
- Bored (cased or uncased): some major highways and some bitumen roads

Bored crossings shall be installed in accordance with the alignment sheets and construction drawings, responsible authority requirements and approval conditions.

Three alternative methods were investigated for watercourse crossings. These were:

- Open trench. The majority of watercourse crossings are expected to be constructed using standard open trenching construction. This technique is most suited to the dry or low flow conditions which will be preferred for the construction phase
- Open trench with isolation
- Horizontal Directional Drilling (HDD). HDD may be used to cross major watercourses where standard open cut methods are not feasible or to avoid environmentally sensitive features. The feasibility of using HDD is limited by site conditions such as soil stability, slope, access, available workspace and the nature of subsurface strata

A risk assessment will be undertaken for each watercourse and drainage line crossing to identify the risk of flows occurring during construction, taking into account time of year and catchment characteristics. For streams where there are permanent flows or a risk of flows during construction, a dedicated crossing method shall be applied that:

- Minimises the overall length of time for disturbance, and in particular, the length of time that trenches will remain open in the bed and banks
- Provides for preservation of the sediment/soil profile
- Provides for prompt stabilisation of the bed and banks following pipe placement
- Provides for special reinstatement techniques to restore aquatic ecosystems and prevent scouring and/or pipeline exposure and damage by subsequent flows
- A diversion strategy will be developed and implemented that addresses flow management and fish passage

Clear and grade operations at waterways will be restricted to the minimum necessary for construction purposes and shall be performed in a manner which will minimise the reinstatement requirements. Where trees and vegetation cannot be preserved aboveground, stabilising root material shall be undisturbed wherever possible.

The width of cut in the RoW in the vicinity of the waterway crossings will be minimised and topsoil removed from the banks and approaches to the crossing will be conserved.

After vegetation and topsoil removal and stockpiling, the bed and bank material will be separately stockpiled in a location that will not obstruct the watercourse. Banks will be backfilled with bank material compacted and stabilised.

On completion of works, the beds of the watercourse will be restored and obstructions resulting from construction of the pipeline will be removed and disposed of. The banks of the watercourse crossing shall be restored by grading to the natural contours or to the natural angle of repose of the stream bank material, whichever is less steep.

Timing

Crossings will be undertaken 7 days per week 11 hours per day, from 6.30 am to 6.30 pm with a one hour break (preferably during dry weather). At some crossings work may proceed beyond 6.30 pm to enable steam bed works to be completed that day.

Proposed plant and equipment

The plant and equipment proposed for crossings will include the following:

- Excavator with clamshell bucket
- Front loaders
- Dozers
- Padding machines
- Dumper trucks
- Water tankers

2.5.8 Ancillary GTP construction activities

Fencing

Existing fences intersected by the Mainland GTP RoW will be severed and temporary construction gates will be installed. Fencing will be undertaken in consultation with landholders such that any impacts to stock movements or property maintenance will be minimised. Crews will be instructed on the need for gates to be closed in accordance with landholder requirements.

Timing

Fencing will be undertaken 7 days per week 11 hours per day, from 6.30 am to 6.30 pm (with a one hour break).

Proposed plant and equipment

The plant and equipment proposed for fencing will generally include the following:

- Post hole augers
- Trucks
- Water tankers

Rehabilitation after GTP construction

Waste from construction including pipes, pipe off cuts and spacers will be collected and disposed of in accordance with the Waste Management Plan (WM Plan) (refer Appendix F). On completion of Mainland GTP construction, the RoW will be rehabilitated in accordance with the LRMP (refer Appendix G).

Pipeline markers and signage will be installed along the Mainland GTP.

2.5.9 Construction workforce

The total peak workforce is expected to be 900 (850 contractors and 50 GLNG staff). Construction will occur over an 18 month period. Construction personnel will work 11 hours per day from 6:30 am to 6:30 pm (with a one hour break), seven days per week, working 28 days on with 9 days off and are assumed to be non-resident operating on a fly-in/fly-out basis to be housed in construction camps as described in Section 2.5.10.

2.5.10 Construction camps

General

Construction camps are required to house and accommodate the construction personnel for the Mainland GTP. Construction camps will be constructed within PPL 166. These construction camps will be sized to accommodate approximately 450 persons at main camps and 200 persons at behind and advanced camps. An area of approximately 8 ha will be required for each camp.

These camps will be operational throughout the entire construction period. The size of construction camps will decrease as construction activities in their particular sections are completed. Pre-fabricated modular buildings (camp units) will be transported to the next location and installed to accommodate construction personnel shifting from one section to the next.

The construction camps will consist of camp units for quick installation and re-location. They will be self-contained, self-sufficient and highly mobile, complete with all support systems recommended by the highest industry standards for health, safety and security considerations.

Permanent 'camp cores' will be equipped with facilities including water chlorination systems and grey water/sewage management systems. These sections will remain in place while camp units are moved from core to core.

Construction camp locations

Construction camp sites have been positioned to minimise travel distance for work crews and have been located near a water source.

Four camp sites have been defined and have been located to minimise the travel distance to the work sites. The construction camps will be located at the following locations:

- Camp 1 – Bundaleer – KP 75
- Camp 2 – Bauhinia – KP 180
- Camp 3 – Banana – KP 275
- Camp 4 – Calliope KP – 355

Refer to Figure 2.3 for locations of proposed construction camps.

Construction camp facilities

Proposed camp facilities will typically include:

- Management suite
- Private ensuite
- Shared ensuite
- Kitchen and dining facility
- Wet canteen
- TV room
- Laundry block
- External fridges
- Dry food
- Ablution block
- Office complex
- Generators sets

- Site offices
- Recreational facilities
- Warehouse and lay down area
- Prefabrication workshop
- Equipment maintenance workshop
- Water storage tank
- Reverse osmosis
- Sewage treatment system
- Ice making plant
- Fire-fighting trailer, 2,000 L tank with pump

Sewage treatment plants attached to construction camps will also be located above the Q50 flood levels as per CG Report Appendix 3, Part 2, Condition 8.

Construction camp installation

The mobilisation schedule of construction camps is based on the logistic and construction priorities as required for the project implementation.

In preparation of camp installation, the proposed site will be filled, compacted and graded to an adequate elevation above the existing ground level to allow the proper slope for drainage.

The installation of each construction camp (including area preparation) will take approximately 20 to 25 days and will be undertaken 7 days per week 11 hours per day, from 6.30 am to 6.30 pm (with a one hour break).

The plant and equipment proposed for construction camp installation include:

- Loaders
- Graders
- Trucks
- Trucks equipped with working tools

2.5.11 Gladstone logistic base

A logistic base (in the Gladstone area) will be established and operational for the duration of the Project and will include the following features:

- Equipment maintenance workshop
- Fuelling facilities for vehicles
- Warehouse and lay down yard
- Prefabrication workshop

The Gladstone logistic base at Auckland Point (Lot 300) used for a temporary pipe receiving area (for the Mainland and Curtis Island GTP sections) is the subject of a separate approval to the Mainland GTP.

2.5.12 Transportation

Transportation of pipe from overseas to Project

The pipe joints for the Project will be shipped from overseas in 12 m lengths. Shipments are expected to arrive at the Port of Gladstone and Port Alma, between December 2011 and September 2012.



It is expected that 15 shipments will be delivered in this 10 month period at a rate of approximately 42,000 m of pipe per month. Of the 15 shipments, around 11 ships will head to Port Alma and four ships will head into the Port of Gladstone.

Unloading of each ship is expected to take four days working at a working rate of 24 hours per day. Approximately 28,300 pipe joints (around 130,000 tonnes) will be shipped into Port Alma and 6,700 pipe joints (around 30,000 tonnes) will be shipped into Port of Gladstone.

The pipes will then be transferred from the wharf offloading facilities (at each port) to a temporary pipe storage area by semi-trailer.

The temporary pipe receiving areas are close to each port. At these sites the pipes will be temporarily stockpiled ready for pick-up and delivery to the temporary pipe storage sites (located along and within the RoW) (refer Figure 2.3).

The Port Alma temporary pipe receiving area is located on the Bajool-Port Alma Road (Lots 5, 6 and 96), which is approximately 20 km west of Port Alma. It has a capacity to store 15,000 pipe joints.

The Port of Gladstone temporary pipe receiving area is located at Auckland Point Logistics Base (Lot 300). Pipe distribution for the Curtis Island GTP and Marine Crossing GTP sections has been outlined in the Curtis Island GTP EM Plan and the Marine Crossing GTP EM Plan.

Transport of pipe to temporary pipe storage sites

General

The nominated traffic route for distribution of pipe from Auckland Point (Gladstone) to the Gladstone end of the Mainland GTP will be via along the Port Access Road, Hanson Road, Blain Drive to Dawson Highway and then to the temporary pipe storage sites located along the Gladstone end of the Mainland GTP RoW. The distribution of this pipe to Gladstone end of the Mainland GTP will require approximately (5,834 pipe joints) for the 70 km section. This equates to approximately 1,459 semi-trailer loads (based on four pipes per load in lengths of 12 m) resulting in approximately 21 truck loads (42 trips) per day from Port Central at its peak. The traffic route for distribution of pipe is illustrated in Figure 2.3.

The balance, approximately 340 km for the western section of the Mainland GTP will be transported from Port Alma's temporary pipe storage area (Lots 5, 6 and 96) on the Bajool-Port Alma Road to the proposed temporary pipe storage sites located along the Mainland GTP RoW via a combination of heavy vehicle routes, including the Bruce Highway, Capricorn and Leichhardt Highways and Dawson Highway. In particular, delivery of these pipes from Lots 5, 6 and 96 will require approximately 7,083 semitrailer loads (four pipes per load in lengths of 12 m.) to achieve the maximum pipe laying rate of 50 km per month. This pipe cartage rate is expected to generate a maximum of 25 semi-trailer loads per day during daylight hours.

The traffic route for distribution of the pipe to the western section of the Mainland GTP is illustrated in Figure 2.3.

Temporary pipe storage areas

Pipe for the Mainland GTP will be transported via road to one of eleven temporary pipe storage sites. Pipe will be picked up horizontally by crane or side-boom with spreader bar and slings/belt or by vacuum lift and placed down in rows within these storage areas.

The size of each temporary pipe storage site will typically be 8 ha (approximately 200 m X 400 m) and will be able to accommodate a maximum of 60,000 pipes. Each site will be located adjacent to the RoW.

These temporary pipe storage site locations have been selected based on their accessibility by main roads; close proximity to access roads and the RoW; suitability, size and minimisation of environmental impact. The locations are described in Table 2.4 and illustrated in Figure 2.3.

Table 2.4 Proposed temporary pipe storage area locations

Temporary pipe storage areas	KP along RoW	Estimated pipe storage at that site(m)
1	10	32,500
2	55	30,000
3	70	52,500
4	160	57,500
5	185	40,000
6	240	50,000
7	285	35,000
8	310	22,500
9	330	27,500
10	365	30,000
11	390	30,500

The location of the temporary pipe storage sites is presented in Figure 2.3.

Construction of the temporary pipe storage sites will typically involve:

- Flat, stable land will be identified and will be provided with drainage features/sediment controls
- Soft cushions of sand covered with polyethylene sheets will be constructed to support the pipes. The pipes will be stacked on these sand berms supported by at least two bunds at equidistant locations from pipe ends.
- Pipes will be stacked with a maximum of four tiers in each stack location
- Access road will be constructed around and in-between stacks to facilitate loading/offloading activities

These sites will be reinstated in accordance with the LRMP once the entire pipe has been delivered to the RoW for stringing and there is no longer a need to retain the temporary pipe storage site.

Timing

The timing for transporting of pipe from the temporary pipe receiving areas at the ports to the temporary pipe storage areas along the RoW is scheduled to occur between December 2011 and October/November 2012.

All road transport of pipe will be carried out during daylight hours (allowing 10 hours per day) and will cart for 23 days per month. It is estimated that around 230 working days will be required to complete delivery of all pipes to the temporary pipe storage sites along the RoW.

Proposed plant and equipment

Equipment required at the temporary pipe storage sites is as follows:

- Cranes
- B-doubles
- Semi-trailers
- Workshop truck

Transport of plant, equipment and other construction related materials

Other heavy vehicle movements associated with the pipeline construction will include the transport of the construction equipment to the RoW and mobilisation and demobilisation of the construction camps.

At the beginning of the construction period it is estimated that approximately 1,000 vehicles will be mobilised to the construction camps from Gladstone. It is estimated that the majority will be heavy vehicles (approximately half Class 9 and half Class 3).

Equipment and materials will be moved on a daily basis from the construction camps to the RoW for construction activities. Many of these trips may occur on local roads and access tracks and the RoW itself.

Transport along the Mainland GTP RoW and access tracks

Primary access to the Mainland GTP RoW will be via major roads in close proximity to the RoW, which include the Carnarvon Highway, Dawson Highway, Leichhardt Highway, Burnett Highway and Bruce Highway. The existing local road network will be accessed from these roads to provide immediate access to the RoW.

All access to and from the RoW which will include the access tracks and hauls roads will be via dedicated wash down facilities. These have been located throughout the Project area (refer Figure 2.3 for location of dedicated wash down facilities). These dedicated wash down facilities will be used to control pest and weeds and will therefore be operated in accordance with the Pest and Weed Management Plan (PWMP) (refer Appendix D).

Access tracks will be maintained during construction and rehabilitated to the pre-existing state following completion of construction activities (where ongoing operational access is not required) and in accordance with landholder requirements.

It is estimated that up to a maximum of 700 vehicles will move along the RoW per day. These daily trips are based on the full workforce being on site during the approximately 15 months of peak construction activities. This equates to approximately 116 peak hour trips, which is mostly made up of construction personnel movements from the accommodation facilities to the construction sites along the RoW.

Transport of construction personnel

Construction of the Mainland GTP will occur over an 18 month period and construction personnel will work 11 hours per day from 6:30am to 6:30pm with a one hour break, seven days per week, on a 28 days on, 9 days off labour cycle.

Construction personnel will use commercial flights from Brisbane, Roma, and Rockhampton airports to Gladstone city. Construction personnel will be transferred to the construction camps via project vehicles and buses. These bus trips will be scheduled to minimise the peak demand and to coordinate movements with flight schedules.

Daily movements will also include the transport of construction personnel to and from the construction camps to the construction sites along the RoW. Construction personnel will be transferred to their respective camp sites on dedicated buses. It is also considered that construction personnel movements will be predominately along the RoW and will not be along local roads or adjoining highways. Construction personnel will move from camp to camp as construction progresses.

2.5.13 Site mobilisation and demobilisation

Traffic movements associated with mobilisation and demobilisation of construction camp facilities are anticipated to occur several times as construction moves along the RoW. These activities will only be affecting the road network in these brief periods when equipment is moved from one construction camp location to the next location. These periods of site setup and equipment movement are each expected to occur over a one week period.

2.5.14 Construction waste management

The construction process is not expected to generate large quantities of non reusable or non-recyclable materials. The anticipated waste streams from the construction process generally falls into one of the follow broad areas:

- General waste
- Recyclable waste such as paper, cardboard, plastics, glass, aluminium and timber
- Putrescible waste
- Medical and first-aid waste
- Scrap metals
- Sanitary waste
- Hydrotest water
- Waste oils and chemicals
- Regulated waste

The construction of the Mainland GTP will generate varying materials through the construction process. The management of these various waste streams is presented in Chapter 13 and also in the Waste MP (refer Appendix F).

2.6 Mainland GTP operation

2.6.1 Description of operational activities

The operation of the Mainland GTP will be in accordance with the EA, the Projects Health, Safety and Security Management Plan (HSSMP), AS 2885, the APIA *Code of Environmental Practice* (2009) and the Operational Management Plan (OMP), which will be developed and implemented prior to operation.

The OMP will include a maintenance program that will include leak detection and external coating surveys, ground and/or aerial patrols, repair or replacement of faulty/damaged components, internal cleaning of the GTP, corrosion monitoring and remediation, and easement and lease area maintenance.

Aerial and/or ground inspections will include checking for encroachment activities close to the Mainland GTP corridor, discolouration of vegetation which can be an indicator of a gas leak, detection of erosion, monitoring of rehabilitation success and detection of weed species. Monitoring of the cathodic protection system will be undertaken in accordance with the requirements stipulated in the OMP. The frequency of monitoring to be included in the OMP will be determined during the development of the detailed operating procedures and detailed design (prior to commencement of operation).

The operational workforce for the entire GTP (including the Mainland GTP) is anticipated to be between 15 and 20 persons. This crew will be responsible for undertaking the operational and maintenance activities as described above. Further details of the key operational and maintenance activities are provided below.

Operational monitoring

The Mainland GTP is to be monitored remotely from a gas control centre via a supervisory control and data acquisition system located at the LNG Facility by operations personnel.

Ground patrols

Ground control inspections by operations personnel will be carried out along the GTP RoW by vehicle and foot patrols to check on the condition of the RoW and identify any activities that may have the potential to impact on the integrity of the pipeline. The frequency of these inspections will be stipulated in the OMP. The inspections will also be undertaken as per the monitoring and auditing measures stipulated OMP. Typical inspections will include, but not be limited to, a review of:

- Activity on the Mainland GTP corridor and in the vicinity
- Use of access tracks and pipeline corridor and any unauthorised traffic
- Access track condition and maintenance requirements
- Evidence of erosion, washouts or land subsidence
- Evidence of pipeline exposure
- Vegetation cover
- Excess vegetation on the pipeline corridor
- Weed and pest infestation
- Condition of pipeline crossings
- Disturbance to protected heritage sites
- Indications of leaks
- The presence of refuse or litter
- Damages to fences, gates, signs, markers etc
- Security of sites and evidence of unauthorised entry

Additional patrols will be undertaken after heavy storms or significant events to check for damage to the pipeline. In particular, low level remediation for erosion, subsidence and weeds is likely to be necessary primarily during the first 12 months following construction.

Aerial surveillance

Aerial patrols by operations personnel along the Mainland GTP RoW will be undertaken on in accordance with the programme stipulated in the OMP. Typical aerial surveillance will check for:

- Bare patches or damaged vegetation (indicating possible leaks or erosion)
- GTP exposure
- Scouring, sink holes, areas of active or potential erosion
- Condition of water crossings
- Noxious weed areas
- Ploughed areas and/or evidence of third party activity
- Areas of limited revegetation success
- Vegetation regrowth

Internal pipeline inspection

Internal pipeline inspections are required to monitor the integrity of the pipe which will be carried out by intelligent pigs on an as-required basis.

Cathodic protection surveys

A cathodic protection system is required to protect the pipe and it will be installed along the length of the Mainland GTP, and will be checked in accordance with the requirements as stipulated in the OMP.

Issue specific monitoring

The OMP will identify areas that require a high level of monitoring. These areas will be incorporated into the OMP operational monitoring program and monitored.

Special ground, marine and/or aerial patrols may be undertaken after heavy storms or earthquakes to check for damage to the RoW.

2.7 Decommissioning

2.7.1 Description of decommissioning activities

The Mainland GTP has a design life and an expected operation life of 42 years. At project closure, it will be decommissioned or reused in consultation with regulatory authorities and other potential users.

In the event that the Mainland GTP is no longer required, it will be decommissioned in accordance with the legislative requirements of the day, AS2885 and the *APIA Code of Environmental Practice* (2009) or equivalent of that time.

2.8 Relevant stakeholders

There are a number of stakeholders that will be both directly and indirectly affected by construction and operation of the mainland GTP. There are approximately 93 private landholders that will be directly affected. There have also been discussions with landholders to determine fair compensation, pipe alignment issues and timing to reduce the impact on their property as a result of GTP activities.

In addition to landholders being affected, residents and services within the following communities may also be indirectly impacted:

- Taroom
- Bilolea and Moura
- Duaringa
- Rolleston and Springsure
- Emerald
- Woorabinda
- Theodore
- Banana

Other relevant stakeholders include:

- Government (local and State in their capacity as both regulator and land owner in some cases)
- Relevant Aboriginal groups and Traditional Owners
- Other proponents

- Overlapping tenement holders
- Parties requiring crossing agreements
- Infrastructure providers

2.9 Proposed environmentally relevant activities

This EM Plan supports an application for an EA for Chapter 5A activities which are described as Environmentally Relevant Activities (ERA's) under the *Environmental Protection Act 1994*. Details of the relevant chapter 5A activities and the chapter 4 activities that could be included are provided in Table 2.5.

Table 2.5 Environmentally relevant activities

Environmentally relevant activity	Comment
3. A petroleum activity that is likely to have a significant impact on a category A or B environmentally sensitive area	The GTP will impact on Category B environmentally sensitive areas
5. Constructing a new pipeline of more than 150 km under a petroleum authority	The Mainland GTP will be approximately 406 km in length, however the overall GLNG GTP will be approximately 420 km long
8. A petroleum activity, other than a petroleum activity mentioned in items 1 to 7, that includes a chapter 4 activity for which an aggregate environmental score is stated	See below, Schedule 5 - Level 1 Chapter 5A
Schedule 2, Activity 8 – Chemical Storage	It is estimated that each 450 person temporary construction camp will store approximately 200 m ³ of diesel and a 200 person camp will store 100 m ³
Schedule 2, Activity 17 – Abrasive blasting	Pipe joints, welds and pipe ends and possibly cold pipe bends will require abrasive blasting to remove rust and scale prior to welding
Schedule 2, Activity 38 – Surface coating	Pipes will be coated with a corrosion protection substance
Schedule 2, Activity 47 – Timber milling and wood	Some timber removed from the RoW may be milled or chipped as part of project activities
Schedule 2, Activity 50 - Bulk material handling	Loading and unloading of pipes and other construction material will occur as part of project works
Schedule 2, Activity 63 – Sewage treatment	Accommodation camps will cater for up to a maximum of 450 persons. Sewage will be treated in on-site mobile wastewater treatment modules

Source: <http://www.legislation.qld.gov.au/LEGISLTN/SLS/2008/08SL370.pdf>

2.10 Notifiable activities

The following Notifiable Activities may occur in association with the construction of the Mainland GTP:

1. Abrasive blasting—carrying out abrasive blast cleaning (other than cleaning carried out in fully enclosed booths) or disposing of abrasive blasting material
7. Chemical storage (other than petroleum products or oil under item 29)—storing more than 10 t of chemicals (other than compressed or liquefied gases) that are dangerous goods under the dangerous goods code
23. Metal treatment or coating—treating or coating metal including, for example, anodising, galvanising, pickling, electroplating, heat treatment using cyanide compounds and spray painting using more than 5 L of paint per week (other than spray painting within a fully enclosed booth)
29. Petroleum product or oil storage—storing petroleum products or oil:
 - a) In underground tanks with more than 200 L capacity
 - b) In above ground tanks with;

- i) For petroleum products or oil in class 3 in packaging groups 1 and 2 of the dangerous goods code—more than 2500 L capacity
- ii) For petroleum products or oil in class 3 in packaging groups 3 of the dangerous goods code—more than 5000 L capacity
- iii) For petroleum products that are combustible liquids in class C1 or C2 in Australian Standard AS 1940, 'The storage and handling of flammable and combustible liquids' published by Standards Australia—more than 25000 L capacity

2.11 Cumulative impact

The cumulative impact assessment approach taken in this report is aligned with the approach outlined in the CG Report. The aim is to identify potential cumulative impacts related to the pipeline routes on the Mainland GTP as part of the identification of management measures which have a multi-project component. In doing so it considers the following:

- Sensitive receptors (environmental values): stated receptors of defined sensitivity upon which impacts may be caused
- Project Scope/Assessment Scenario: the combination of projects being assessed
- Temporal scope: time period over which impacts are assessed and extent to which overlapping or contiguous timeframes for different projects contribute to cumulative impacts
- Geographical scope: geographical extent of the assessment of direct and indirect impacts
- Cumulative impacts: as defined in the CG report
- Cumulative impact mitigation: Specific measures for mitigating cumulative impacts (as opposed to those for stand-alone projects)

2.11.1 Sensitive receptors

The environmental values are taken as the starting point for identifying the cumulative impacts. The receptors affected by cumulative impacts are described in the relevant chapters of this EM Plan.

2.11.2 Temporal scope

It is proposed to assess a construction only scenario which considers both the cases of maximum likely intensity (ie greatest project overlap) and maximum likely duration.

2.11.3 Geographical scope of cumulative impacts

The Mainland GTP is part of a larger linear development. Consistent with the CG report on the GLNG project, this EM Plan does not cover the entire section of the route. Separate documents cover the Marine Crossing and Curtis Island sections.

This EM Plan refers to the cumulative impacts of the GTP RoW within the GSDA Materials Transportation Services Corridor from the Bruce Highway to KP 406 and the CICSDA. This is the section of the Mainland GTP RoW that is co-located with other proponents in corridors. The geographical scope of the assessment is based on the spatial extent of the impacts and the area within which the projects interact including:

- The footprint of the development
- Downstream surface water and groundwater potentially influenced by construction activities
- Habitat of fauna outside these areas influenced by activities in areas above through severance of migratory pathways

- The geographical extent to which potential social, economic, community impacts may be generated by pipeline construction
- The geographical extent to which potential traffic and transport impacts may be generated by pipeline construction

2.11.4 Cumulative impact identification approach

Impact Identification

Identification of cumulative impacts involves the following steps:

- Establish clearly-identifiable scenarios for the construction of each of the proposed pipelines
- Identify the activities within each *scenario* in aggregate as distinct from each project and establish the temporal scale for when these activities occur
- Identify the impacts that result from each activity and where similar impacts result from different activities
- Identify receptors affected by each impact
- Evaluate the impacts on each receptor

Impact Scoring

This EM Plan contains a qualitative assessment using a matrix based comparison of project activities, timescales and impacts with environmental values using professional judgement and reference to previous studies. An indicative evaluation of the impact will be undertaken based on the magnitude of impact (ie the size of the potential change to the environment resulting from the Project) and the sensitivity of the affected receptor. The approach to scoring of impacts is displayed in Table 2.6.

Table 2.6 GLNG cumulative impact scoring

Significance	Description	Matrix Indicator
Major negative	Widespread, prolonged and/or large magnitude impacts affecting the quality or viability of a receptor at a state or national level. Should be avoided or eliminated wherever possible, and otherwise offset or fully compensated. Plans of specific mitigation and targeted monitoring program must be included in the EMP	***
Moderate negative	Locally widespread and/or moderate magnitude impacts affecting quality or viability of a receptor at a Regional or local level. of specific mitigation and targeted monitoring program must be included in the EMP	**
Minor negative	Localised, short term and/or low level impacts managed by standard environmental management practices and routine monitoring	*
Negligible	No measurable impacts following implementation of standard measures	N
Positive	Impacts where a beneficial impact on the receptors are anticipated	+
Permanent	Impacts that are effectively permanent	(P)

3. Environmental management system

3.1 Environmental management

The Mainland GTP EM Plan is to provide sufficient information for the administering authorities to evaluate the Project in relation to the regulatory requirements of the EA for the PPL and the conditions of the EPBC Act approval. The Mainland GTP EM Plan is aligned with the Queensland Government guidelines: *Preparing an Environmental Management Plan (EM Plan) for Coal Seam Gas (CSG) Activities* (DERM 2010).

Not all the impacts of the Project, especially location specific design detail is known at this time and therefore the EM Plan recognises that there is a continuous improvement process that leads from the concept to the detail. This EM Plan therefore provides the values and commitments which are to inform the detailed design, construction and operation of the GTP. The detailed design of the GTP will inform the construction methodology and also the method of operation and maintenance (refer Figure 3.1).

The role of the Mainland GTP EM Plan is to identify the primary environmental values; the potential environmental impacts; and means of managing and mitigating these. The Mainland GTP EM Plan also identifies who is responsible and what are the performance criteria for measuring the achievement of objectives and what are the triggers for corrective action.

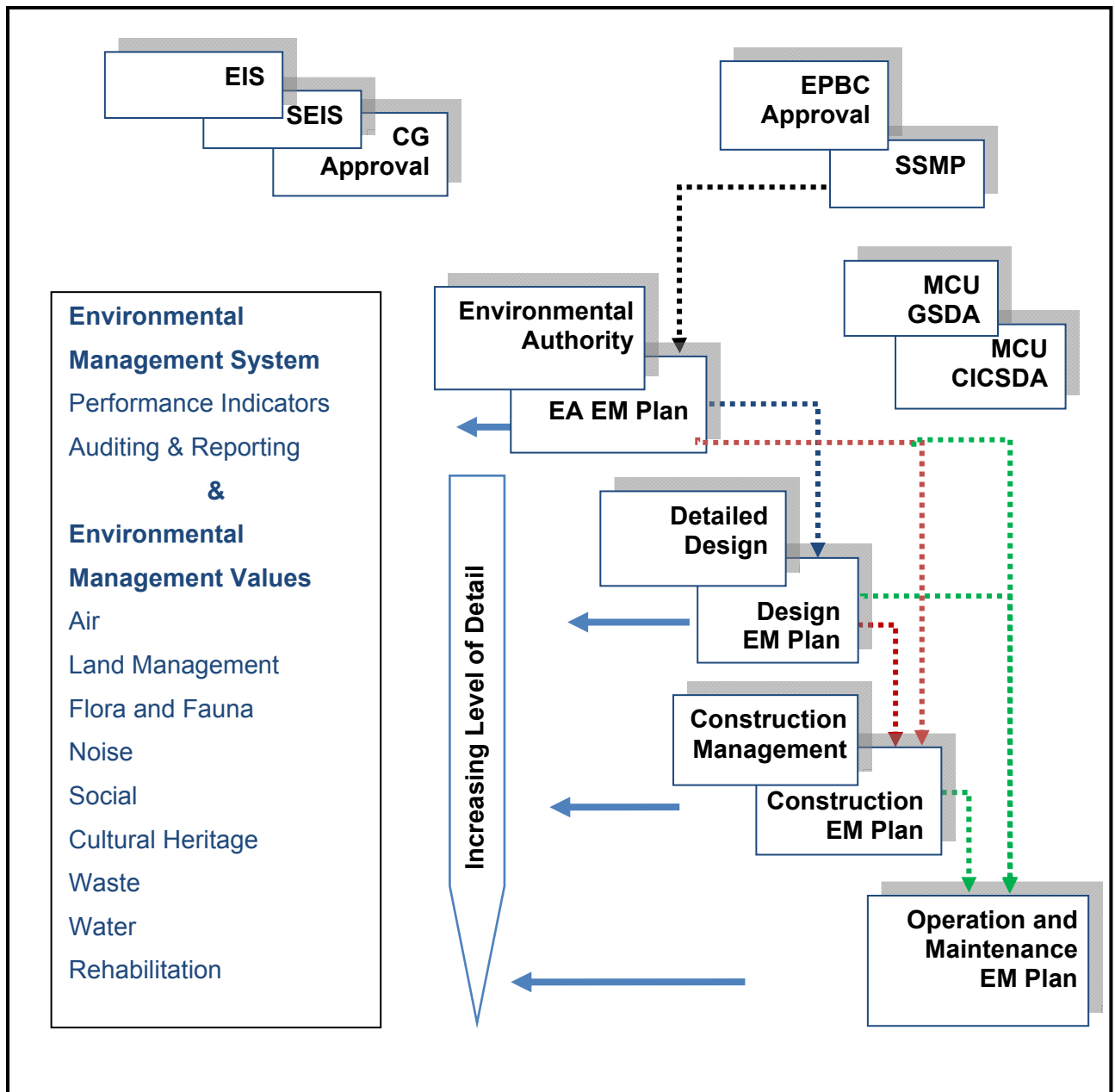


Figure 3.1 Future environmental documentation processes

3.2 Health, Safety and Security

A Project Health, Safety and Security Management Plan (HSSMP) has been developed and describes the GLNG Operations personnel and EPC Contractor responsibilities for managing Health, Safety and Security (HS&S) issues during the implementation phase of the Project. This is the primary Project document for the overall management of health, safety and security matters. The specific purpose of this HSSMP is:

- To clearly detail the health and safety objectives and expectations and provide guidance for GLNG Operations and EPC Contractor personnel in satisfying them
- To list personnel responsibilities (or reference associated documents in which these are detailed)
- To document the methods by which health, safety and security issues shall be identified, communicated and managed

- To list the systems, processes, tools, risk controls and mitigation measures to be used in achieving the health, safety and security objectives

This HSSMP will be progressively updated by the Health, Safety and Security Manager – GLNG Operations as the risk profile of the project changes and as new relevant information becomes available to ensure that potential hazards and impacts associated with the current phase of the project are understood, minimised and the required HS&S support is provided.

The GLNG Operations HSSMP is a working document that will be revised and re-issued as necessary.

3.3 Roles and responsibilities

GLNG Operation’s staff and contractors will be responsible for implementing this EM Plan in a manner which complies with all relevant environmental standards, adheres to all legislative requirements and ensures that all environmental objectives associated with the work are achieved.

Contract documents for the detailed design, construction, maintenance and operation will include the environmental commitments in this EM Plan, as well as requiring compliance with the EA, design and construction specifications, technical drawings and the general environmental duty.

All staff are responsible for the environmental performance of their activities and for complying with the General Environmental Duty as outlined in the EP Act. Specific environmental responsibilities assigned to organisational roles are detailed in Table 3.1.

Table 3.1 Specific environmental responsibilities

Position	Overview
GLNG Operations Pipeline Project Manager	The GLNG Operations Pipeline Project Manager is ultimately responsible for the standard of management, including environmental management. To assist in fulfilling this responsibility, the GLNG Operations Pipeline Project Manager is supported by a series of specialised personnel
Construction Manager	The Construction Manager is responsible for all construction activities including planning, procedure’s approvals and execution of works. The Construction Manager is also responsible for ensuring that adequate provision is made for compliance activities
Engineering Manager	The Engineering Manager is responsible for generating the design drawings and specifications consistent with the EM Plan and AS2885 – the Australian Pipeline Standard
Pipeline Construction Superintendent	The pipeline Construction Superintendent will direct work in a manner that complies with all relevant environmental procedures; adheres to all legislative requirements and ensures that all environmental objectives associated with the Project are achieved. The Construction Superintendent has “stop task” and “stop work” authority
Environmental Manager	The Environmental Manager will direct work in a manner that complies with all relevant environmental procedures; adheres to all legislative requirements and ensures that all environmental objectives associated with the Project are achieved. The Environmental Manager has “stop task” and “stop work” authority
Construction Contractor	The Construction Contractor is responsible for ensuring compliance with this EM Plan and the development and implementation of a Contractor specific EM Plan. This will include training of personnel (refer Section 3.5), provision and maintenance of equipment, facilities and associated services and consumables and the monitoring of compliance to this EM Plan

3.4 Project specific documentation

3.4.1 Key management plans

Erosion and sediment control plan

An erosion and sediment control plan (ESCP) (refer Appendix A) has been developed to outline erosion and sediment control measures to be implemented during construction of the Mainland GTP RoW to limit potential adverse impacts.

Species management plan

A Species Management Plan (SMP) has been prepared and addresses the impacts to all affected flora and fauna species (regardless of status) and habitat, provides for the survival of the species in the wild and achieves a net conservation benefit for the species. The SMP will be provided to DERM for approval prior to commencing construction.

Significant species management plan

A Significant Species Management Plan (SSMP) has been prepared and details the specific mitigation measures for the mitigation or offsetting of all impacts to significant flora and fauna species as stated in the CG Report. The SSMP will also be provided to DERM for approval prior to construction commencing.

Pest and weed management plan

A Pest and Weed Management Plan (PWMP) (refer Appendix D) has been prepared and details the requirements for the management of pest and weeds associated with the construction of the GLNG GTP (including the Mainland GTP RoW). It outlines pest and weed management protocols for the various stages of the GLNG GTP and clearly defines the boundaries and procedures throughout the project area to ensure all preconstruction activities (surveys, landholder access, site visits, infrastructure upgrades and preparation) do not transfer Class 1 or 2 weeds from areas currently infested to new “clean” areas.

Mosquito and midge management plan

A Mosquito and Midge Management Plan (MMMP) (refer Appendix E) has been prepared and outlines measures for the control of mosquitoes and midges whose populations could increase as a result of project activities

Social impact management plan

A Social impact management plan (SIMP) has been developed for the Project and outlines measures to reduce any potential adverse impacts that the local community may be subjected to as a result of the proposed works. The SIMP is currently being reviewed by the relevant authorities.

Waste management plan

A Waste Management Plan (Waste MP) (refer Appendix F) has been prepared and specifies criteria and standards for the management of waste for all sections of the project including the Mainland GTP.

Landscape rehabilitation management plan

A Landscape Rehabilitation Management Plan (LRMP) (refer Appendix G) has been developed and specifies criteria and standards for rehabilitation and monitoring of all areas impacted by pipeline activities.

Operational management plan

An Operational Management Plan (OMP) will be developed once construction is complete. The OMP includes a summary of legal and community requirements and the responsibilities of all levels of personnel involved with the project, along with guidance on the management of environmental impacts during operational activities.

3.5 Induction and training

GLNG Operations' personnel, contractors and visitors are required to undertake relevant environmental training and induction programs. Personnel will not be allowed to access the project site unless properly trained. Competencies and training results from the assessment of all staff and contractors will be identified and recorded.

All managers and supervisors will be responsible for ensuring that personnel under their control have the requisite competencies, skills and training to carry out their assigned tasks in accordance with the requirements of this EM Plan. They will also be responsible for identifying additional training and competency requirements.

All staff will complete a comprehensive project induction. The induction will include a comprehensive review of environmental requirements and standards, safety, and access protocols. All project supervisors and managers will have additional detailed training on the use and implementation of this EM Plan.

All managers and supervisors will hold regular toolbox meetings with personnel to discuss issues associated with their scheduled work. This will include highlighting and discussing relevant environmental issues. Any environmental issues will be captured and reviewed through the hazard identification system.

All staff working on the GTP will receive training as to the following:

- The environmental policy of GLNG Operations and the Contractor
- Any relevant environmental objectives and targets
- Control procedures to be implemented for routine operations for day to day activities to minimise the likelihood of environmental harm, however occasioned or caused
- Basic identifying features of declared weeds including the major weed species posing as a threat within and to the area
- Weed reporting procedures
- Weed risk assessment forms and vehicle washdown requirements
- Completion of the DEEDI Weed Hygiene Declaration and vehicle/machinery inspection report
- Explanation of any quarantine zones and relevant procedures for decontamination that apply
- Contingency Plans and Emergency Response Plans (ERPs) to be implemented for non-routine situations to deal with foreseeable risks and hazards, including corrective responses to prevent and mitigate environmental harm
- Organisational structure and responsibility to ensure that roles, responsibilities and authorities are defined to ensure effective management of environmental issues
- Effective communication procedures to ensure two-way communication on environmental matters between operational staff and higher management
- Obligations with respect to monitoring, notification and record keeping obligations under this EM plan and relevant approvals and procedures outlined in this EM Plan and the CEMP;
- Monitoring of the release of contaminants into the environment including procedures, methods and record keeping

All personnel will be made aware of potential contamination issues during induction. Site inductions will also consist of fire safety awareness training.

3.6 Environmental monitoring

Monitoring programs will be undertaken in accordance with this EM Plan. Routine environmental monitoring of the Mainland GTP will be conducted to ensure performance standards adopted for the Project comply. Monitoring, undertaken by project operational and corporate personnel and specialist service providers, will be periodically conducted in accordance with site-specific monitoring plans.

Specialist studies to investigate particular aspects of the environment (eg flora and fauna, weeds, hydrological risk) will be periodically commissioned when a need is determined during environmental review and risk assessment.

Suitably qualified, experienced and competent person(s) will conduct all monitoring. All monitoring results will be recorded, compiled and kept for a minimum of five years and made available for inspection upon request from the administering authority.

Monitoring results relating to rehabilitation will be kept until the relevant petroleum tenure is surrendered.

The weed control program will consist of the following strategies:

- Vehicle and equipment washdowns
- Record keeping
- Close monitoring
- Spraying
- Vehicle stickers
- Training
- Management of vehicle movements

An annual return will be prepared and submitted to the relevant administering authority.

If requested by the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC), all species and ecological survey data and related survey information from ecological surveys undertaken for MNES will be provided. The data will be collected and recorded to conform to data standards notified from time to time by the Department.

3.7 Reporting, recording and auditing

During construction and operation, compliance audits will be conducted in accordance with the requirements of this EM Plan as well as construction procedures, relevant legislation, license and permit conditions and industry standards. To ensure stakeholders are adequately informed of relevant EHS performance, reports, where necessary will be prepared for internal and external stakeholder review.

All inspection and audit reports of environmental performance will be stored in the Proponent's electronic database which will record incidents, complaints and audit finding and enable corrective actions identified during the inspection / auditing process to be recorded, tracked and closed out. Third party audits will be conducted to determine compliance and the reports from these audits provided to the Coordinator General.

External audits will be undertaken on an annual basis by an independent auditor approved by the Minister. The audits will be conducted in accordance with AZ/NZ ISO9011.2003

Guidelines for Quality and/or Environmental Systems Auditing and section 458 of the EPBC Act and may be used to verify compliance with the EPBC Act approval.

The external auditors report will document the following:

- The components of the project being audited
- The conditions that were activated during the period covered by the audit
- A compliance/non-compliance table
- A description of the evidence to support audit findings of compliance or noncompliance
- Recommendations on any non-compliance or other matter to improve compliance
- A response by the proponent to the recommendations in the report (or, if the proponent does not respond within 20 business days of a request to do so by the auditor, a statement by the auditor to that effect)
- Certification by the independent auditor of the findings of the audit report.

Audits or summaries of audits carried out under these conditions, or under section 458 of the EPBC Act, may be posted on the Department's website. The results of such audits may also be publicised through the general media.

Based on the outcomes of the auditing process, the following will be undertaken:

- Implement any recommendations in the audit report, as directed in writing by the Department after consultation with the proponent
- Investigate any non-compliance identified in the audit report
- If non-compliance is identified in the audit report - take action as soon as practicable to ensure compliance with these conditions

In addition to the monitoring and reporting requirements documented in the relevant sections of this EM Plan, the following auditing regime will be implemented:

- During construction, the Contractor will be required to report on environmental compliance of an incident, on a monthly basis with a corrective actions process established
- During construction, internal audits will be undertaken at regular intervals to verify that all work is proceeding in accordance with this EM Plan
- A post-construction audit of the Mainland GTP RoW and other related infrastructure will be conducted annually for two years following completion of construction to evaluate revegetation, erosion and soil stability, weed control, watercourse alteration prevention and success of bed and bank re-profiling
- GLNG Operations will act upon any matters contained within the audit report and record the findings in the database to facilitate, investigate, close out and remediate actions as appropriate
- Following the submission of the audit report, GLNG Operations will provide written advice to the Co-ordinator General and DSEWPaC for review and will address the following:
 - Actions taken to ensure compliance with the conditions in the CG Report
 - Actions taken to routinely prevent a recurrence of any non-compliance issues
- When first becoming aware of a non-compliance, the Contractor will:
 - Undertake action to bring the matter into compliance within an effective time frame
 - Report the non-compliance and remedial action to GLNG Operations, who will report up to DSEWPaC within the specified timeframe
- Environmental incidents (including complaints) will be recorded on a database and addressed. Each incident will be investigated to determine the underlying causes and actions to prevent recurrences



GLNG Operations will also produce an Annual Environmental Return, which will be submitted to DSEWPaC electronically, within 20 business days of each anniversary date from the date of Commonwealth approval. The Annual Environmental Return will document the following information:

- Addresses compliance with the conditions of the EPBC Act approval.
- Detail where there was any unavoidable impacts on MNES, mitigation measures applied to avoid impacts on MNES; and any rehabilitation work undertaken in connection with any unavoidable impact on MNES.
- Detail all non-compliances with the conditions; and
- Detail any amendments needed to plans to achieve compliance with the conditions.

Regulatory agencies will be notified of non-conformance with statutory approvals within the specified timeframe.

Relevant records supporting inspections and audits (in addition to monitoring and other critical aspects of the management system) will be generated and maintained. GLNG Operations will:

- Maintain accurate records substantiating all activities associated with or relevant to these conditions of approval, including measures taken to implement a plan approved under these conditions
- Make those records available on request to the Department.

3.8 Emergency response

GLNG Operations recognises that emergencies arising from activities could have serious and long term health and safety effects (HSE). The Proponent will develop and implement an Emergency Response Plan (ERP) to address emergency situations at the operating sites, premises and relevant functions. The ERP will outline the emergency procedures and describe the organisation, defining members, tasks, responsibilities and role of the emergency response team. The ERP will include the following:

- Information outlining the connection to relevant legislation as well as specific Project Environmental Management Plans
- Inclusion of the District Officers from the local police districts to represent the Queensland Police Service (QPS) as a stakeholder when developing the Emergency Response Plan (ERP)
- Communication and coordination between GLNG Operations and the District Disaster Management Group regarding the project's activities
- Development of a response, investigation, command, control and recovery for both natural disasters and other disasters/emergencies and incidents
- Information outlining the connection to relevant legislation as well as specific project EM Plans
- Engagement with QPS and other agencies in emergency response exercises
- Response procedures in the event of a fire, chemical release, spill, leak, explosion, equipment failure, bomb threat, natural disaster (including severe storm and flood events) or any other likely emergency
- Communication arrangements and contact details
- Roles and responsibilities of responsible personnel
- Emergency controls and alarms
- Evacuation procedures
- Emergency response equipment
- Leak detection and control points





- Training requirements
- Site access and security

4. Financial assurance

The financial assurance (FA) for the Mainland GTP has been prepared in accordance with the DERM's Guideline "*Financial Assurance for Chapter 5A Activities*" using quantities determined from this EM Plan.

4.1 Background

Under section 312O of the EP Act, the administering authority may require the giving of financial assurance in a stated form or amount.

The purpose of the FA is to provide security for compliance with the environmental authority and certain costs and expenses.

The proposed amount of FA for the Mainland GTP has been:

- Calculated on a project basis (ie may cover several petroleum activities on one or more petroleum authorities);
- Based on estimates for the work to be completed by third party contractors to ensure that the total cost of rehabilitation is specific to the site and is a realistic estimate of the cost expected to be incurred by government should it be required to rehabilitate the disturbed areas (the Estimates cover the full extent of work necessary to meet the conditions of the environmental authority); and
- Estimated using the *Schedule of disturbance for chapter 5A projects*.

The main components of the schedule of disturbance that contribute to the annual rehabilitation costs are:

- The Total Rehabilitation Cost – which is the sum of the rehabilitation costs [R] for each type of disturbance and partly rehabilitated areas. The costs are calculated using the formula below:
 - Rehabilitation Cost [R] = Unit Rehabilitation Cost [C] x Disturbed Area [A]
 - where C = the unit rehabilitation cost (ie the cost per unit area to complete rehabilitation for each type of disturbed or partially rehabilitated area)
 - A = maximum significantly disturbed area for each type of disturbance (eg evaporation pond) proposed during the period of the work program or development plan including any carryover of existing significant disturbance at commencement of program or plan

Consumer Price Index (CPI) – has been incorporated into the estimate of FA to cover inflation for the term of the work program or development plan.

Goods and Services Tax (GST) – rate of ten percent on all taxable supplies listed above that do not include GST in them.

The amount of FA that is required is defined as the maximum total rehabilitation cost for complete rehabilitation of all disturbed areas, which may vary on an annual basis due to progressive rehabilitation. The amount required for the FA must be the highest total rehabilitation cost calculated within the period covered by the work program or development plan.

4.2 Project specific financial assurance

The GTP financial assurance cost estimate has been developed by an independent consulting firm. The FA estimate is based on a combination of contractor bids for specific tasks developed as part of the Mainland GTP FA process and engineering estimates using third-party unit rates.

The Mainland GTP FA estimate has been developed based on the discrete phases of the Mainland GTP lifecycle, with these phases also coinciding with specific years. The Mainland GTP is comprised of four key phases:

- Phase 1 - Project Mobilization and Setup (2011). This phase is extensive and includes establishment of one construction camp and also includes the sourcing of materials and equipment for the GTP Project
- Phase 2a – GTP Construction (2012), which includes trenching, pipe installation, trench backfilling, GTP easement rehabilitation, rehabilitation of construction camps and removal of contractors' equipment
- Phase 2b – GTP Construction Complete (Q1/Q2 2013), which includes trenching, pipe installation, trench backfilling, GTP easement rehabilitation, rehabilitation of construction camps and removal of remaining contractors' equipment
- Phase 3 – Abandonment of the completed GTP and monitoring (Q3/Q4 2013 to 2016). In this phase of the Project, the ultimate disposition of the GTP is unknown, and as a result, costs have been allowed to protect the GTP for future use (eg by installation of cathodic protection)
- Phase 4 – Formal abandonment of the GTP (2017) involving cut, capping and slurry filling of the GTP under key road and infrastructure crossings to ensure that future corrosion of the GTP and settlement does not lead to damage to roads and infrastructure

In addition to the consideration of the Mainland GTP lifecycle, the FA estimate for the Mainland GTP also considers the work process developed by Mainland GTP contractors. In this work process, the contractors have proposed to conduct activities simultaneously with disturbance meaning that construction and restoration will be occurring simultaneously. This work process is most critical in Phase 2 (GTP construction) where work tasks are fully integrated in a manner such that trenching, welding, pipe placement, trench backfilling and rehabilitation activities are being conducted simultaneously. This process minimises the length of trench open at any one time and the extent of area that requires rehabilitation. As this construction is occurring over a prolonged period, the FA has been calculated in two sub-phases, Phase 2a and Phase 2b.

Specific to Phase 2a, the scrap value of pipe has also been considered in the process. Consistent with the waste hierarchy (refer Chapter 13), it has been assumed that if the Mainland GTP is terminated in a partially complete state, any surplus pipe and pipe not installed will be cut and sold as scrap. In order to be conservative, and to reflect the potential that a contractor could remove all pipe but not complete other rehabilitation and restoration tasks (including backfilling of trenches and reseeding), the value of scrap materials have only been used to offset the costs associated with handling and removal of the Mainland GTP for scrap. In the FA calculations, the estimates provide the net proceeds from scrap resale however, where the proceeds exceed the cost of demolition and processing, the value in the estimation tables has been set to \$0.

All costs have been developed in accordance with DERM requirements for level 1 petroleum activities and have been calculated based on independent estimates using third-party unit rates. The estimates for rehabilitation and restoration of areas of soil disturbance were developed in accordance with the detailed methodologies provided in the EIS (URS, 2009).

Considering the lifecycle of the Mainland GTP, estimates of the FA requirements for the phases discussed above are provided as follows:

- Phase 1 – Project Mobilisation and Setup (2011) – \$1,386,000
- Phase 2a – GTP Construction (construction approximately 70% complete with pipe available for scrap value – projected for 2012) -\$17,144,000

- Phase 2b – GTP Construction Complete (all pipe installed and 2 camps and Horizontal drilling equipment demobilized – projected for Q1/Q2 2013) - \$13,589,000
- Phase 3 – Abandonment of GTP Asset and Monitoring (Q3/Q4 2013 - 2016) - total FA over 3+ year period: \$12,520,000 (includes monitoring of restoration)
- Phase 4 – Formal Abandonment of GTP Asset (2017) – \$5,784,000

The schedules of disturbance for each of the phases are provided in Tables 4.1 to 4.5.

The peak FA estimate, which is predicted to occur in Phase 2b, covers the first and second quarter of 2013. This includes costs associated with demobilising all equipment, rehabilitation costs associated with the planned disturbances, and required costs for monitoring and maintaining the restoration work. The estimate is based on the following planned activities:

- Reinstatement of the Mainland GTP RoW
- Backfill open trench
- Installation of Cathodic Protection System on newly installed pipe
- Demobilisation of:
 - Contractor facilities and mobile equipment
 - Temporary camps/laydown areas
 - Surface facilities
 - Stabilisation of road crossings
- Reinstatement of weed control facilities, temporary dams and laydown areas
- Nitrogen purge of newly installed buried pipe to ensure it is inert
- Monitoring of rehabilitation activities

Post-construction of the Mainland GTP, restoration and rehabilitation activities will be limited to monitoring, installation and operation of cathodic protection (refer Chapter 2), and purging of the Mainland GTP after gas transmission commences. It has been assumed that the cathodic protection will be maintained and monitored. Should the project not proceed, it is assumed the cathodic protection will be maintained until 2016 to allow for reuse of the GTP. If a use has not been identified within this timeframe, the Mainland GTP will be abandoned in accordance with regulatory requirements.

The FA estimate will be reviewed and maintained based on the reporting and auditing undertaken to ensure compliance with the conditions of the Project.

5. Air quality

5.1 Chapter summary

This chapter describes the existing air environment, the potential environmental effects of the construction of the Mainland GTP on ambient air quality, and identifies suitable mitigation and management measures to address potential impacts.

A quantitative air impact assessment has been undertaken to identify potential sources of air emissions from activities associated with construction and operation of the Mainland GTP and to investigate mitigation measures to ensure adverse air quality impacts do not occur as a result of these activities. The study considered the following:

- Existing environment within the GTP RoW study area
- Sources, nature and quantity of air emissions
- Predicted concentrations of air pollutants downwind of the construction area
- Mitigation measures to reduce the identified potential impacts

5.1.1 Summary of existing air quality values:

- The most representative available meteorological monitoring station for climate reporting for the Mainland GTP RoW is the Bureau of Meteorology's (BoM) Gladstone Airport monitoring station
- DERM operate an ambient air quality network in the Gladstone region, and data are available to define the regional airshed. A summary of monthly maximum 24-hour PM₁₀ concentrations measured by DERM over the past two years is presented later in this document
- Sensitive receivers identified in the vicinity of the Mainland GTP RoW include commercial and residential places
- Variations in local air quality along the Mainland GTP RoW will occur due to the proximity of sources such as local industry, regional events such as bushfires and dust storms, and variations in meteorological conditions such as wind speed, wind direction and atmospheric stability.
- Preliminary emissions estimates were completed for all nearby identified receptors.

5.1.2 Summary of impacts on air quality values

Construction

Dust and particulate emissions associated with construction and earthworks have the potential to adversely impact on amenity and human health. Dispersion modelling of the construction and operations of the Mainland GTP RoW and construction camp indicates that, while unlikely some sensitive receptors could potentially be impacted by the pollutants investigated. Despite this, the mitigation measures presented in Section 5.8 will be adopted to minimise potential air quality impacts at unidentified sensitive locations and to protect the health of workers involved in the construction project.

A number of sensitive receivers have been identified as being at risk of experiencing exceedences of the 24 hour PM₁₀ levels as per the Department of Environment and Resource Management (DERM) *Environmental Protection (Air) Policy 2008* guidelines. While construction work is undertaken in the vicinity of these receptors, extra attention will be paid to dust mitigation activities. This would include increasing the frequency of watering of haul roads and access track within the RoW and limit construction activities during periods of high wind speeds.

Operation

Monthly inspections will be carried out along the Mainland GTP RoW by vehicle and foot patrols to check on the condition of the GTP and associated infrastructure. Typically maintenance on the Mainland GTP RoW will be carried out by light vehicles and small maintenance crews on an annual basis, or as and when required.

Air quality impacts from these operational activities are expected to be acceptable and manageable due to the low number of vehicles movements, infrequent maintenance activities and separation distances from the Mainland GTP RoW to the sensitive receptors.

Furthermore, all activities and works associated with these operational activities will be in accordance with the OMP.

5.1.3 Summary of proposed mitigation measures

Table 5.1 Environmental protection commitments, objectives and control strategies – air quality

Item	Detail
Environmental protection objective	<ul style="list-style-type: none"> To complete the installation of the pipelines in a manner that maintains ambient air quality within the local airshed
Specific objectives	<ul style="list-style-type: none"> No warranted complaints from landholders, and warranted complaints responded to within 2 working days No excessive dust emissions during construction of the GTP The release of odour, dust or any other airborne contaminant(s), or light from the petroleum activity must not cause an environmental nuisance at any sensitive place or commercial place
Control strategies	Refer to Table 5.23 for air quality control strategies to be implemented during construction and operation of the Mainland GTP
Performance indicators	<ul style="list-style-type: none"> Complaints responded to within 2 working days No excessive dust emissions during construction of the Mainland GTP

5.2 Emission sources

The GTP on the Mainland involves three distinct phases, which may result in emissions to air:

- Construction of the pipeline;
- Operations of the pipeline; and
- Closure and rehabilitation of the RoW.

The GTP on the Mainland does not involve any point source combustion at any stage of the Project lifecycle. Combustion related air emissions (such as oxides of nitrogen or sulphur dioxide) are derived from mobile sources (e.g. motor vehicles or earth moving equipment). The effects of these mobile sources are transitory and are present on the RoW for short duration events and would not result in ground level concentrations of combustion gases in exceedence of guideline values. Consequently, these gases are not considered further in this assessment.

Particulate emissions may have the potential to cause impacts at sensitive receptors and need to be further assessed to determine the magnitude and possible duration of impact.

The most significant potential for release of particulate is during the construction period. After commissioning the pipeline, periodic inspection of the RoW will occur and this is expected to involve driving along the pipeline with no surface disturbance. Decommissioning is not expected to involve removal of the pipeline, or similar activity which would result in disturbance of the ground. Any release of particulate matter would be minor and of short duration.

The construction activity on the Mainland is assumed to move at 50 km per month meaning that the effects from the construction equipment will be very transitory and for short periods of time.

5.3 Air quality criteria

The legislative framework for management of Queensland's environment is the EP Act. Subordinate legislation under the EP Act establishes particular values of the environment to be enhanced or protected through Environmental Protection Policies. For the air environment values to be enhanced or protected are identified in schedules attached to the Environmental Protection (Air) Policy 2008 (EPP Air).

Values to be enhanced or protected through the application of the EPP Air, and by extension to the EP Act are those values which are conducive to:

- Protecting the health and biodiversity of ecosystems
- Human health and wellbeing
- Protecting the aesthetics of the environment, including the appearance of buildings structures and other property
- Protecting agricultural use of the environment

Air quality criteria will be set for the project as part of the approvals process. In the interim however, in order to assess the significance of the off-site pollutant concentrations predicted by the modelling study for the construction activities, the following concentrations and deposition rates have been adopted in this EM Plan for the protection of local amenity and human health:

- Particles as PM₁₀: a 24-hour average of 50 µg/m³
- Total suspended particulates (TSP): an annual average of 90 µg/m³
- Dust deposition: an annual average of 120 mg/m²/day

It should be noted that the dust deposition guideline value is not defined within the schedule of the EPP Air, although it is used by DERM as an indication of amenity related concerns and potentially for defining environmental nuisance.

5.4 Existing environment

5.4.1 Climate and meteorology

The most representative available meteorological monitoring station for climate reporting for the Mainland GTP RoW is the Bureau of Meteorology's (BoM) Gladstone Airport monitoring station, which is located approximately 12 km to the south of the eastern end of the Mainland GTP. Long-term climate statistics for Gladstone Airport are discussed below.

Rainfall

Long-term rainfall statistics for Gladstone Airport (1994-2010) are summarised in Figure 5.1. Rainfall peaks during the summer months, with a maximum average of 195 mm recorded during February, which is associated with an average of 11.6 rain days per month. During the remainder of the year, the rainfall is much lower, ranging from 22 – 61 mm/month. The highest monthly rainfall recorded at Gladstone Airport over the time period examined was 657 mm recorded in February 2003.

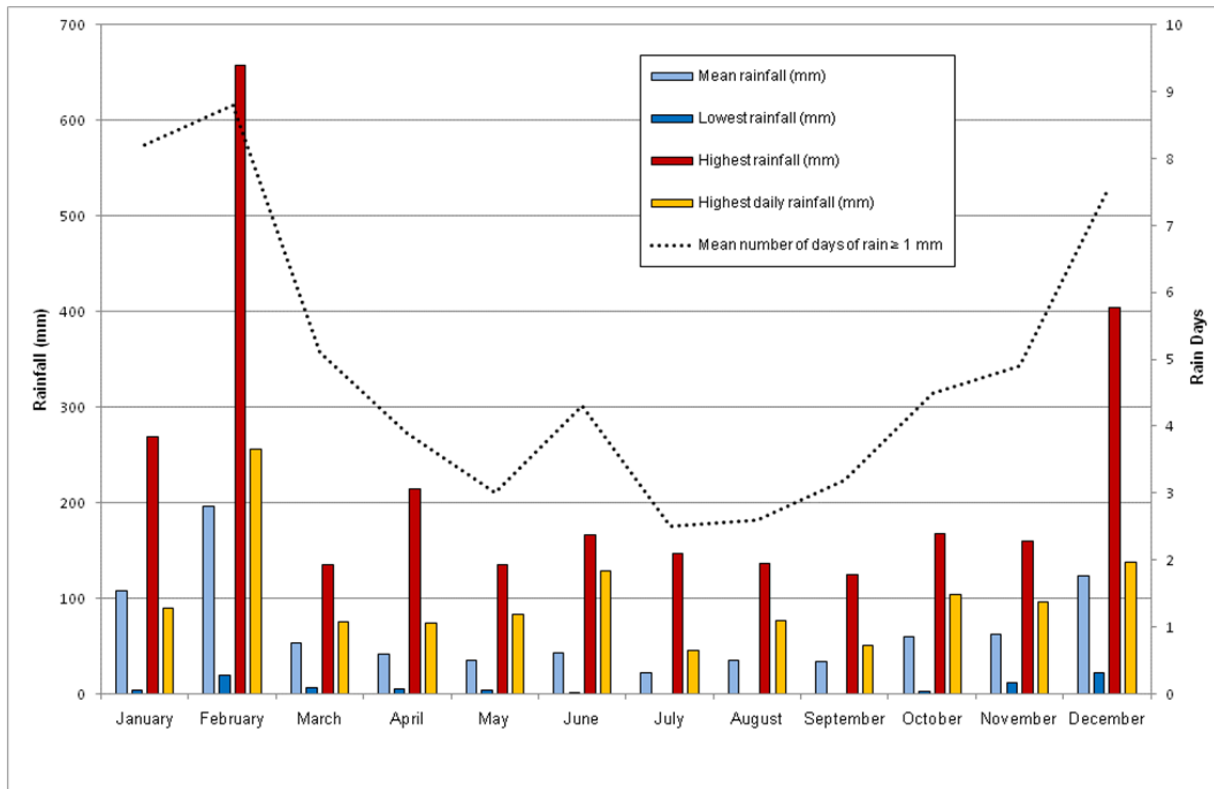


Figure 5.1 Long term rainfall data for Gladstone Airport (1994-2010)

Temperature

Long-term temperature statistics for Gladstone Airport (1993-2010) are summarised in Figure 5.2. Mean maximum temperatures range from 23°C in winter to 31°C in summer, while mean minimum temperatures range from 12°C in winter to 23°C in summer.

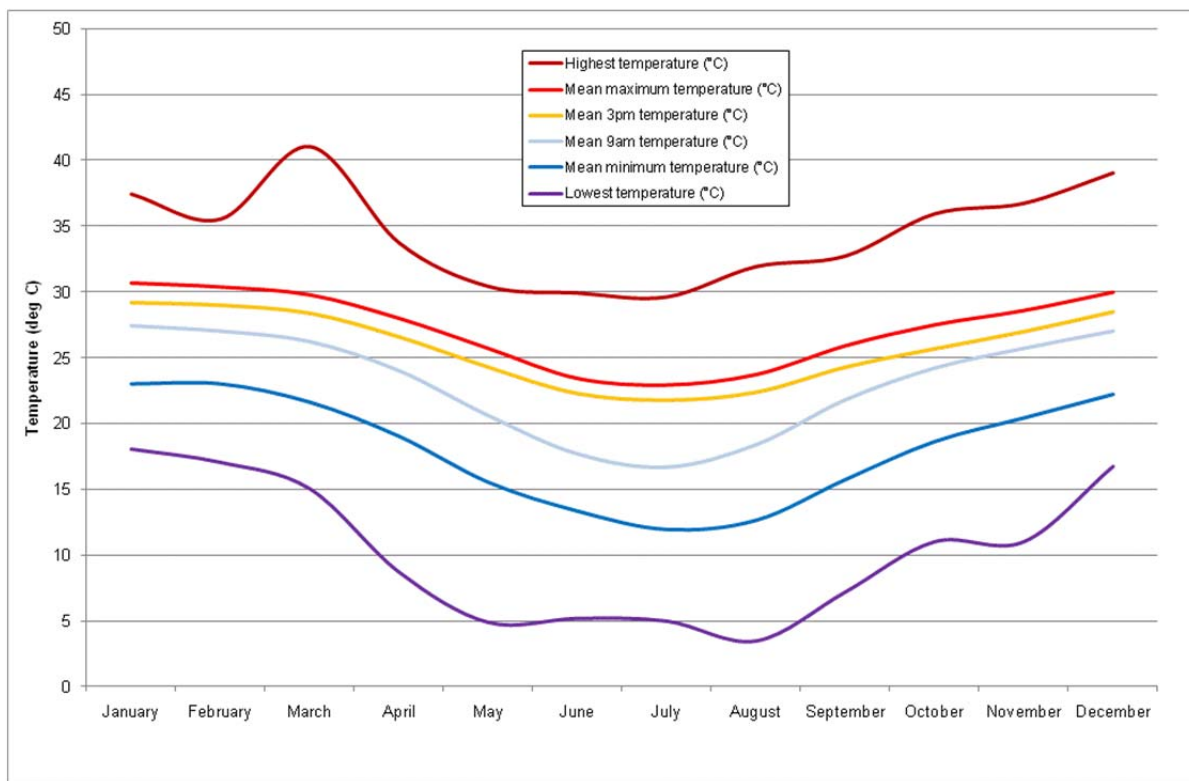


Figure 5.2 Long term temperature data for Gladstone Airport (1993 – 2010)

Wind speed and direction

Analysis of Gladstone Airport meteorology¹ show the following:

- From January to April, morning winds are predominantly south easterlies, shifting to easterlies during the afternoon
- During winter (May to August) morning winds blow predominantly from the southwest to southeast quadrant. In the afternoon, easterly winds continue to predominate, with north easterly winds occurring with increasing frequency over this period
- During spring and early summer (September to December) the morning winds are slightly more widespread, with easterly and south easterlies predominating. In the afternoon, easterly and north easterly winds continue to predominate
- Strong winds (>30 km/hr) generally only occur from the east and are more frequent during the afternoon

5.4.2 Existing air environment

The existing air quality at the eastern end of the Mainland GTP RoW is expected to be affected to some extent by emissions from industrial facilities located in Gladstone and Fisherman's Landing. These facilities include:

- Rio Tinto Alumina's Yarwun refinery
- Cement Australia
- Fisherman's Landing
- Gladstone Power Station

¹ http://www.bom.gov.au/climate/averages/tables/cw_039326.shtml

- Queensland Energy Resources
- QAL Aluminium Smelter
- Gladstone Port

These facilities have the potential to contribute to elevated levels of PM₁₀ at the eastern end of the Mainland GTP RoW under westerly wind conditions. Their influence will be less significant at the western end of the Mainland GTP RoW.

DERM operate an ambient air quality network in the Gladstone region, and data are available to define the regional airshed. A summary of monthly maximum 24-hour PM₁₀ concentrations measured by DERM at Targinnie over the past two years is presented in Figure 5.3. This data shows that at times, exceedances of the *Environment Protection (Air) Policy 2008* (EPP Air (2008)) objective for 24-hour PM₁₀ concentrations of 50 µg/m³ have occurred. The very high reading of 314.6 µg/m³ recorded in September 2009 was associated with a dust storm that swept across New South Wales and Queensland from 22 to 24 September, 2009. Since December 2009, no exceedances of the EPP Air (2009) objective have been recorded.

This recent data is consistent with those used in the EIS Air Quality chapter (URS, 2009). For the purposes of the assessment of the potential impacts of the GTP on the air environment the EIS background concentrations were adopted, i.e:

- Annual average TSP = 30 µg/m³
- 24-hour average PM₁₀ = 30 µg/m³

In addition, an annual average dust deposition of 60 mg/m²/day was assumed. This is half of the study criterion value and will provide a suitable buffer for the assessment of model predictions. It also means that the incremental impact of the Mainland GTP RoW construction activities will be limited to 2 g/m²/month, which is equivalent to the NSW DECCW (DECCW, 2006) incremental impact guideline for deposited dust.

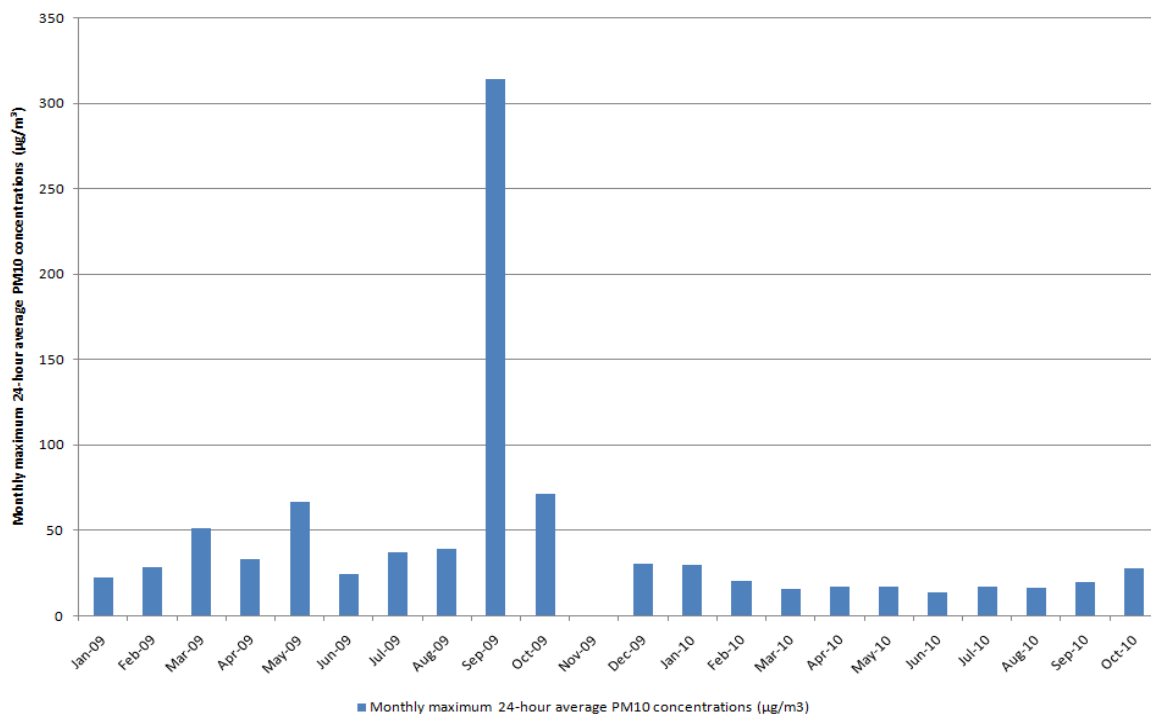


Figure 5.3 Ambient PM₁₀ concentrations measured at Targinnie (January 2009 to October 2010)

5.4.3 Sensitive receptors

Sensitive receivers identified in the vicinity of the Mainland GTP RoW are shown in Table 5.2. The majority of these receivers have been determined as being residential places, with two commercial places also identified.

Table 5.2 Mainland GTP identified sensitive receptors

ID	LOT	PLAN	Easting UTM (m)	Northing UTM (m)	DPE (m)	Address	Suburb	Receiver Type
53	25	FN302	811130	7302388	103	1344 Baralaba-Banana Rd	Banana	Residential
147	49	CTN512	904089	7343058	159	1073 Mount Alma Rd	East End	Residential
54	25	FN302	811077	7302099	170	1344 Baralaba-Banana Rd	Banana	Residential
193	1	RP616661	915636	7367079	218	88 Nichols Rd	Targinnie	Residential
4	4	WT217	688087	7164695	224	Fairview Road	Beilba	Commercial & Residential
43	4	KM74	778064	7290786	243	Avoca Road	Mimosa	Residential
175	1	DT4038	910419	7362891	290	592 The Narrows Rd	Mount Larcom	Residential
199	1305	MPH34872	917601	7366681	317	1023 Targinnie Rd	Targinnie	Residential
200	1	MPH2955	917511	7366954	318	1057 Targinnie Rd	Targinnie	Commercial
127	6	RP843128	875127	7318903	320	8468 Dawson Hwy	Dumgree	Residential
209	1	RP612108	918884	7366716	329	98 Chernih Rd	Targinnie	Residential
167	11	RP905534	908158	7361194	367	265 The Narrows Rd	Mount Larcom	Residential
76	24	RN347	846761	7309966	373	246 Jambin-Dakemba Rd	Dakenba	Residential

DPE: Distance to Pipeline Easement

5.5 Air dispersion modelling

This section presents a summary of a screening air dispersion modelling study that was performed to assess the potential for downwind air quality impacts due to emissions associated with the Mainland GTP construction activities. It outlines the modelling methodology used and the emission sources assessed. The modelling results are presented in Section 5.6.

5.5.1 Overview air dispersion modelling methodology

Modelling of air dispersion along the Mainland GTP RoW was conducted using the CALPUFF dispersion model employing a two-dimensional meteorological dataset that was generated using TAPM. Further details of the approach used are provided below.

5.5.2 Emission sources assessed

Construction works for the Mainland GTP RoW would be carried out in accordance with the requirements of AS 2885 Pipelines – Gas and Liquid Petroleum and the Australian Pipeline Industry Association Code of the Environmental Practice (2009).

Table 5.3 summarises the proposed construction staging and plant items for the Mainland GTP construction works. This summary excludes dust generating activities from the construction of the accommodation camp as it is assumed that the clearing and levelling of the accommodation camp site will generate the most significant levels of dust and therefore represents the highest risk for impacts at nearby receptors.

Emission estimates were compiled for the seven different construction activity scenarios listed in Table 5.3. These scenarios were then ranked according to the total 24-hour PM₁₀ emission rate estimated for each stage of operations and the two highest of these scenarios were modelled. Those scenarios were rock exposure and blasting, and lowering and backfilling (see Section 5.5.5).

Table 5.3 GTP construction staging and typical plant items

Stage (Location)	Description	Typical plant items	Number
RoW and bush clearing (RoW and Accommodation camp)	Graders, front end loaders and dozers are utilised for clearing and grading of the RoW. Trees, timbers and vegetation are stockpiled on the edge of the RoW in preparation for re-spreading during rehabilitation	Motor grader	2
		Dozer	4
		Excavator	2
		Front end loader (FEL)	2
		Vibrating roller	1
		Motor saw	6
		Water tankers	1
		4WD	1
		Minibus 10 seats	2
Rock exposure and blasting (RoW and Accommodation camp)	Large exposed rocks are broken in to small materials using dozers, backhoes and backhoes with hammers. In areas of large rocks drilling and blasting may be required	Dozer	1
		Backhoe	1
		Backhoe with hammer	2
		Rock drill equipment	4
		Explosive truck	1
		Compressor	1
		4WD	3
Stringing and bending	Steel pipe is laid adjacent to the pipeline trench. If required, pipe sections are bent to match changes in the alignment of the pipeline	Sideboom	4
		Bending machine	2
		Road tractor	11
		Semitrailer flat bed (20-30 tonnes)	11
		Truck	2
		4WD	1
		Minibus 10 seats	4

Stage (Location)	Description	Typical plant items	Number
Trenching	Trenches for the GTP are dug.	Backhoe	18
		Backhoe with hammer	2
		Greasing truck	1
		Bus 22 Seats	1
		4WD	2
Welding	Pipe sections are welded together	Sideboom	6
		Pipe facing machine	5
		Crawler tow tractor	2
		Diesel welding machine	2
		Generator (200 kW)	4
		Truck	2
		Bus 50 seats	2
		4WD	1
Lowering and backfilling	Pipe string is lowered into the trench and the trench is backfilled with earth	Dozer	6
		FEL (wheel loader)	7
		Backhoe	8
		Mobile screen. Vulcano – 180 m ³ /hr	4
		Sideboom	5
		Greasing truck	1
		Dump truck	10
		Bus 22 seats	2
		Minibus 10 seats	1
		4WD	2
Clean-up and restoration (RoW and Accommodation camp)	This phase may include contouring and revegetation of the work area	Dozer	2
		Motorgrader	1
		Backhoe	2
		Dump truck	4
		4WD	1

Emission estimates were compiled for six different construction activity scenarios listed in Table 5.3. These scenarios were then ranked according to the total 24-hour PM10 emission rate estimated for each stage of operations and the highest of these scenarios was modelled (lowering and backfilling).

5.5.3 TAPM derived meteorological data

Meteorology is a key input to most dispersion modelling assessments. This is particularly true of assessments that require averaging over long periods of time such as this study. To create realistic meandering of pollution plumes over the averaging period of interest, the modelled meteorology must reflect how the meteorology truly behaves. Ideally, measured meteorology would be used to provide this realism, however due to the remote nature of most of the Mainland GTP RoW, no locally-measured meteorological data is available.

The Air Pollution Model (TAPM) meteorological model (Version 4) was used to develop the meteorological files used in the dispersion modelling. TAPM, developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO), is a prognostic model which is commonly used to generate meteorology in areas where no meteorology exists.

TAPM predicts wind speed and direction, temperature, pressure, water vapour, cloud, rain water and turbulence. The program allows the user to generate synthetic observations by referencing databases (covering terrain, vegetation and soil type, sea surface temperature and synoptic scale meteorological analyses) which are subsequently used in the model to generate site-specific hourly meteorological observations at user-defined levels within the atmosphere.

Table 5.4 details the parameters used in the TAPM meteorological model for this assessment.

Table 5.4 Meteorological parameters used for this study (TAPM v 4.03)

	TAPM location 1	TAPM location 2	TAPM location 3
Number of grids	4	4	4
Grid spacing	30 km, 10 km, 3 km, 1 km	30 km, 10 km, 3 km, 1 km	30km, 10 km, 3 km, 1 km
Number of grid points	25 x 25 x 25	25 x 25 x 25	25 x 25 x 25
Year of analysis	2009	2009	2009
Centre of analysis	688,907m E, 7,210,666m S	800,892m E, 7,298266 m S	310,613m E, 7,371,291m S



(Green triangles mark modelling locations; white squares mark residences within 4 km of the RoW)

Figure 5.4 TAPM modelling locations

Wind speed and direction

Wind speed frequency plots for the three Mainland GTP RoW 2009 meteorological datasets used in the modelling study, (which were extracted from the TAPM meteorological model output at the coordinates shown in Table 5.4), are presented in Figure 5.4. Summaries of the annual wind behaviour predicted by TAPM at these locations are also presented as wind roses in Figure 5.5 to Figure 5.8.

Figure 5.5 to Figure 5.8 indicate that winds experienced at the site are predominantly light to moderate (between 1.5 m/s and 8 m/s) from the northeast and southeast quadrants. The wind roses at the three locations show the following:

- During winter (June to August) winds blow predominately from the south with some winds blowing from the southeast quadrant
- During autumn (March to May) winds blow predominately from the southeast quadrant
- During spring and summer (September to February) winds blow predominately from the north and northeast except at Location 3 where winds blow predominately from the east during spring and in the southeast quadrant during summer

Calm wind conditions (wind speeds less than 0.5 m/s) were predicted to occur around 2% of the time at the three locations throughout 2009.

The seasonal windroses at Location 3 show a similar pattern to that seen in the long term Gladstone windroses, with predominant easterly and south-easterly winds during spring and summer and south-easterly and south-westerly winds being predominant during winter.

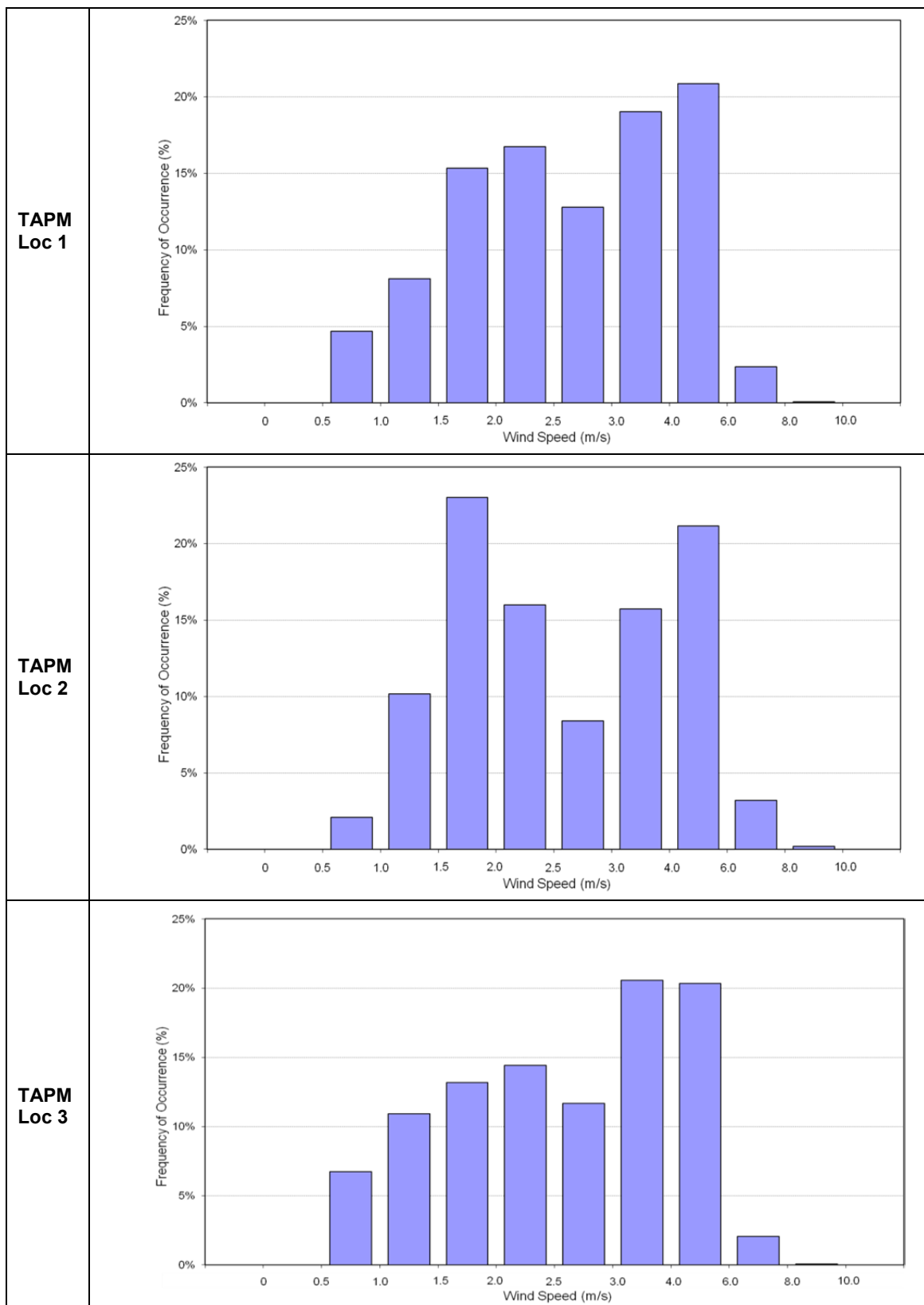


Figure 5.5 Wind speed frequency distributions for the Mainland GTP RoW project area, as predicted by TAPM, 2009

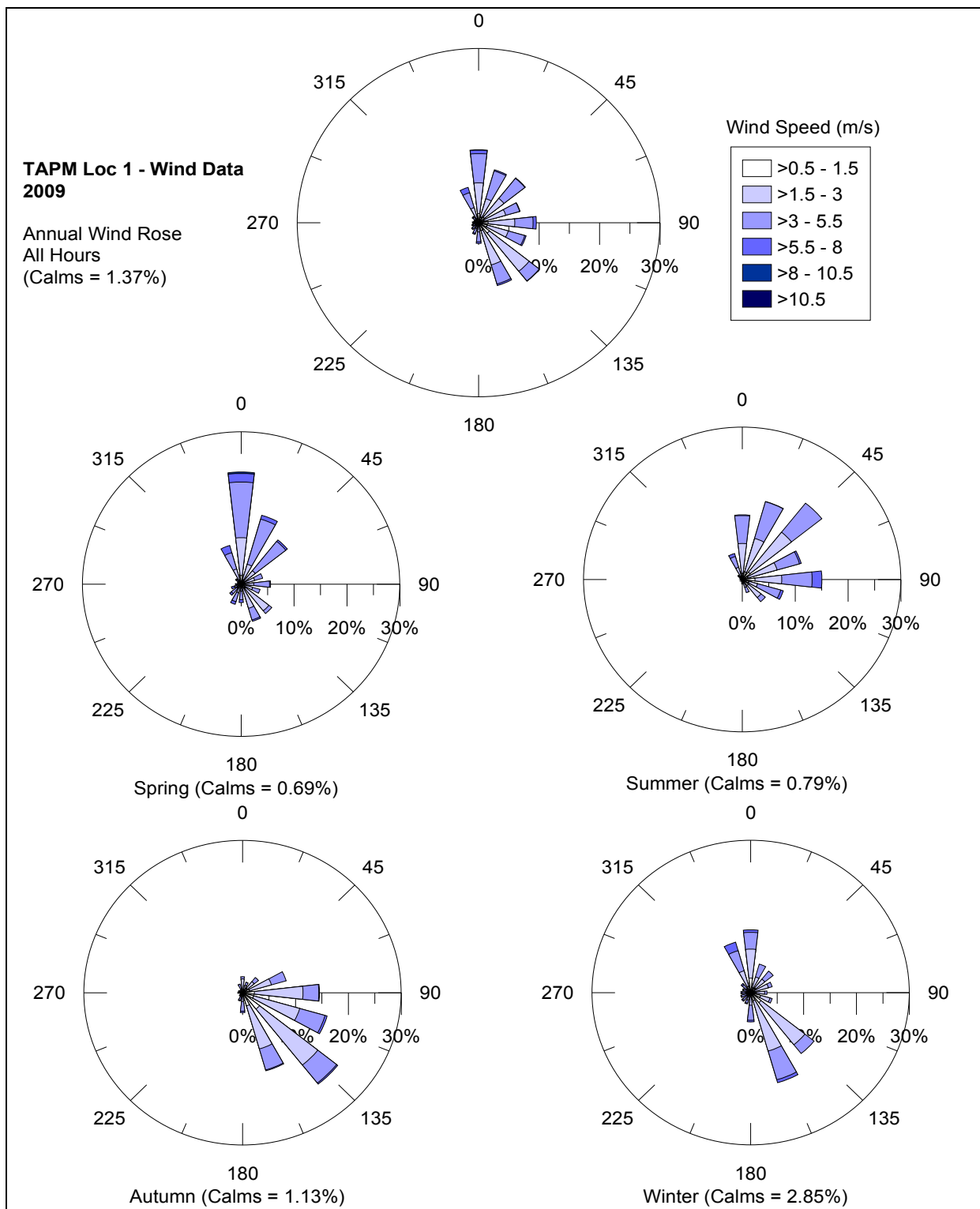


Figure 5.6 Wind roses for Mainland GTP RoW location 1, as predicted by TAPM (2009)

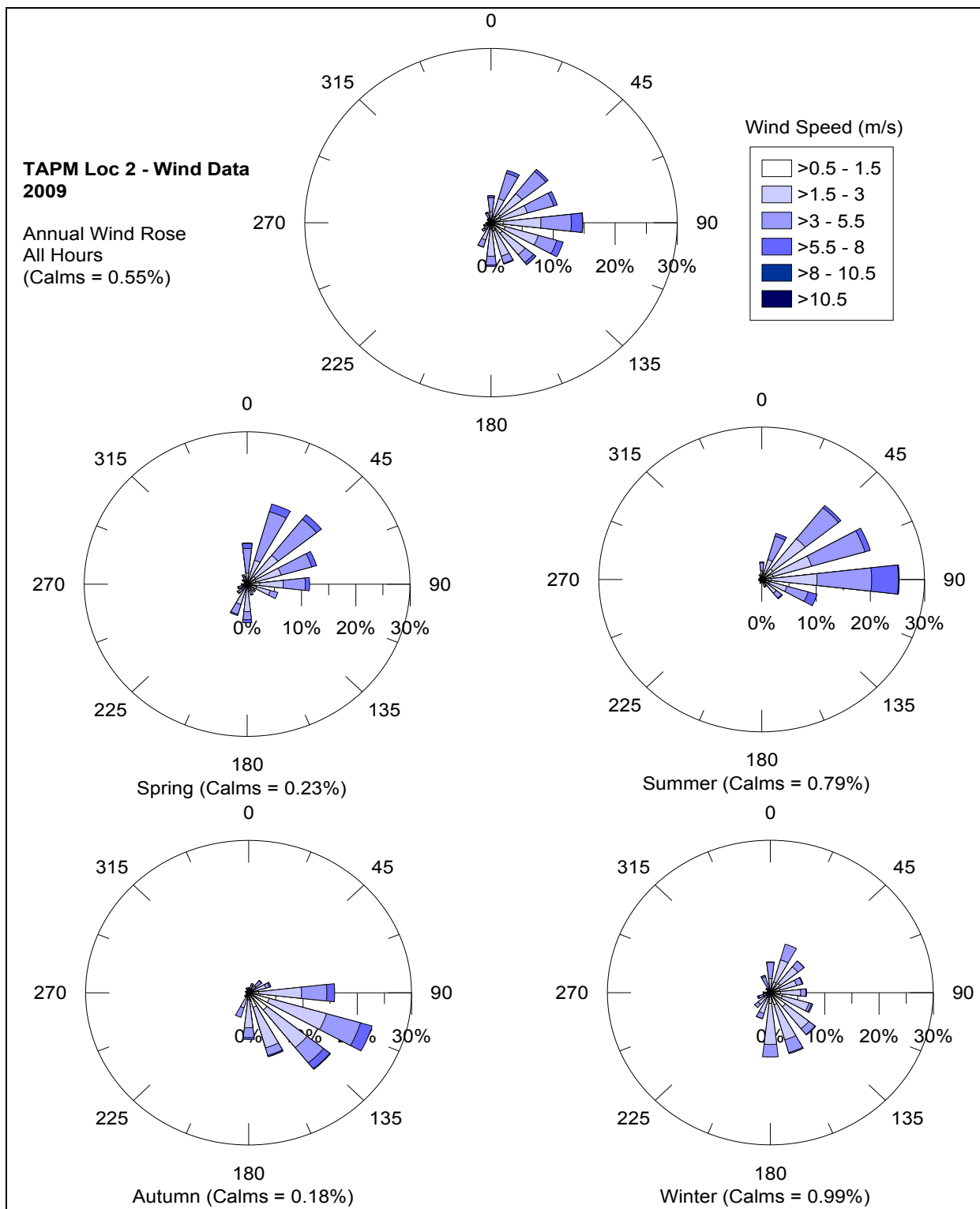


Figure 5.7 Wind roses for Mainland GTP RoW location 2, as predicted by TAPM (2009)

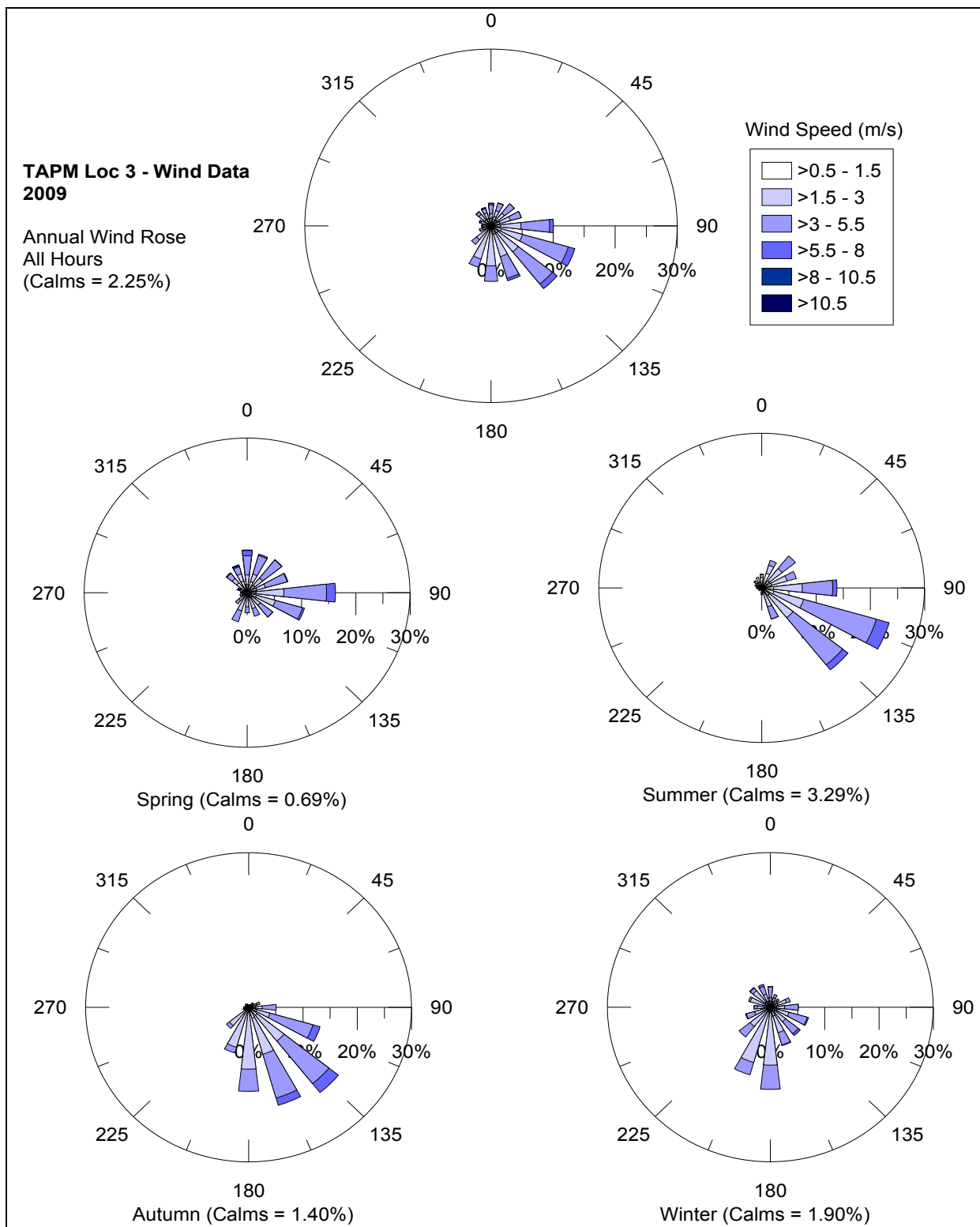


Figure 5.8 Wind roses for Mainland GTP RoW location 2, as predicted by TAPM (2009)

Atmospheric stability

Atmospheric stability refers to the tendency of the atmosphere to resist or enhance vertical motion. The Pasquill-Turner assignment scheme identifies six Stability Classes, A to F, to categorise the degree of atmospheric stability (see Table 5.5). These classes indicate the

characteristics of the prevailing meteorological conditions and are used as input into various air dispersion models.

Table 5.5 Description of atmospheric stability classes

Atmospheric stability class	Category description
A	Very unstable low wind, clear skies, hot daytime conditions
B	Unstable clear skies, daytime conditions
C	Moderately unstable moderate wind, slightly overcast daytime conditions
D	Neutral high winds or cloudy days and nights
E	Stable moderate wind, slightly overcast night-time conditions
F	Very stable Low winds, clear skies, cold night-time conditions

The frequency of each stability class predicted by TAPM at the three locations during 2009 is presented in Figure 5.9. The results indicated high frequencies of Stability Class D and Stability Class F. Location 3 has a very high frequency of conditions typical to Stability Class D (45%). Stability Class D is indicative of neutral conditions, conducive to a moderate level of pollutant dispersion due to mechanical mixing and Stability Class F is indicative of very stable low winds. An extremely low frequency of Stability Class A conditions have been predicted by TAPM for Location 3. These conditions relate to well-mixed atmospheres where there is rapid dispersion. The low frequency of Stability Class A conditions predicted (which is likely to be an underestimate of the actual frequency experienced at the three sites) will therefore result in a conservative over-estimate of impacts by the modelling for this location.

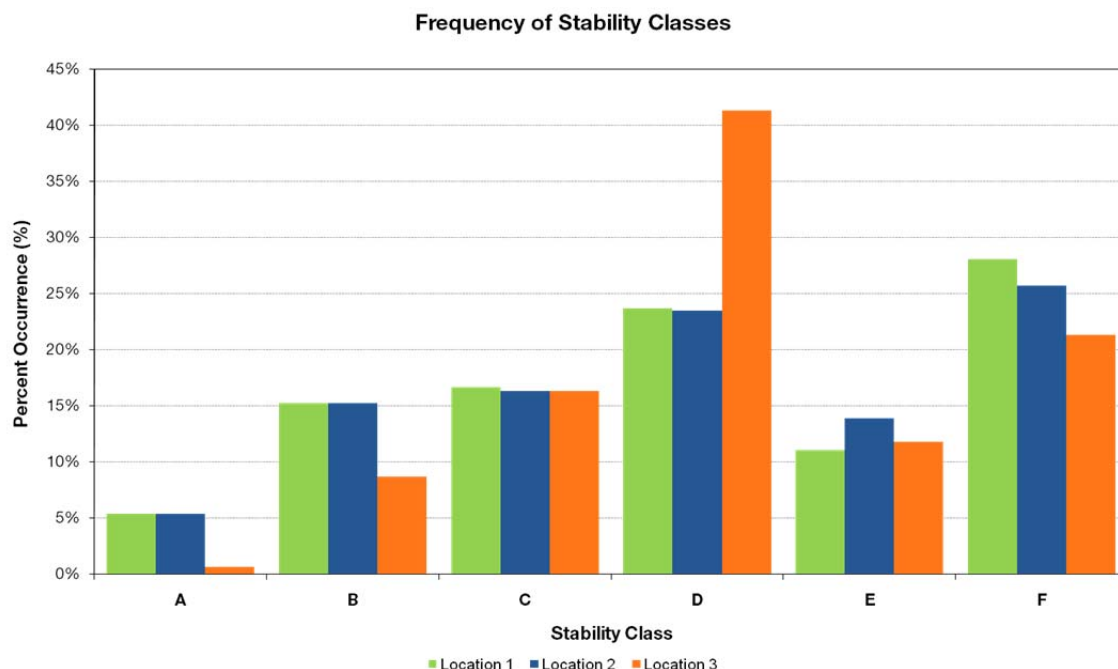


Figure 5.9 Stability class distribution predicted by TAPM for the 3 locations (2009)

Mixing height

Diurnal variations in maximum and average mixing depths predicted by TAPM at the three locations during 2009 are illustrated in Figure 5.10. The data shows a slight increase in the



mixing depth during the morning, arising due to the onset of vertical mixing following sunrise. Mixing height increase during the day peaking in the mid afternoon followed by a rapid decrease as the heat goes out of the day. This pattern is more noticeable at location 1 than at location 3 due to the moderating influence of the ocean on temperature.

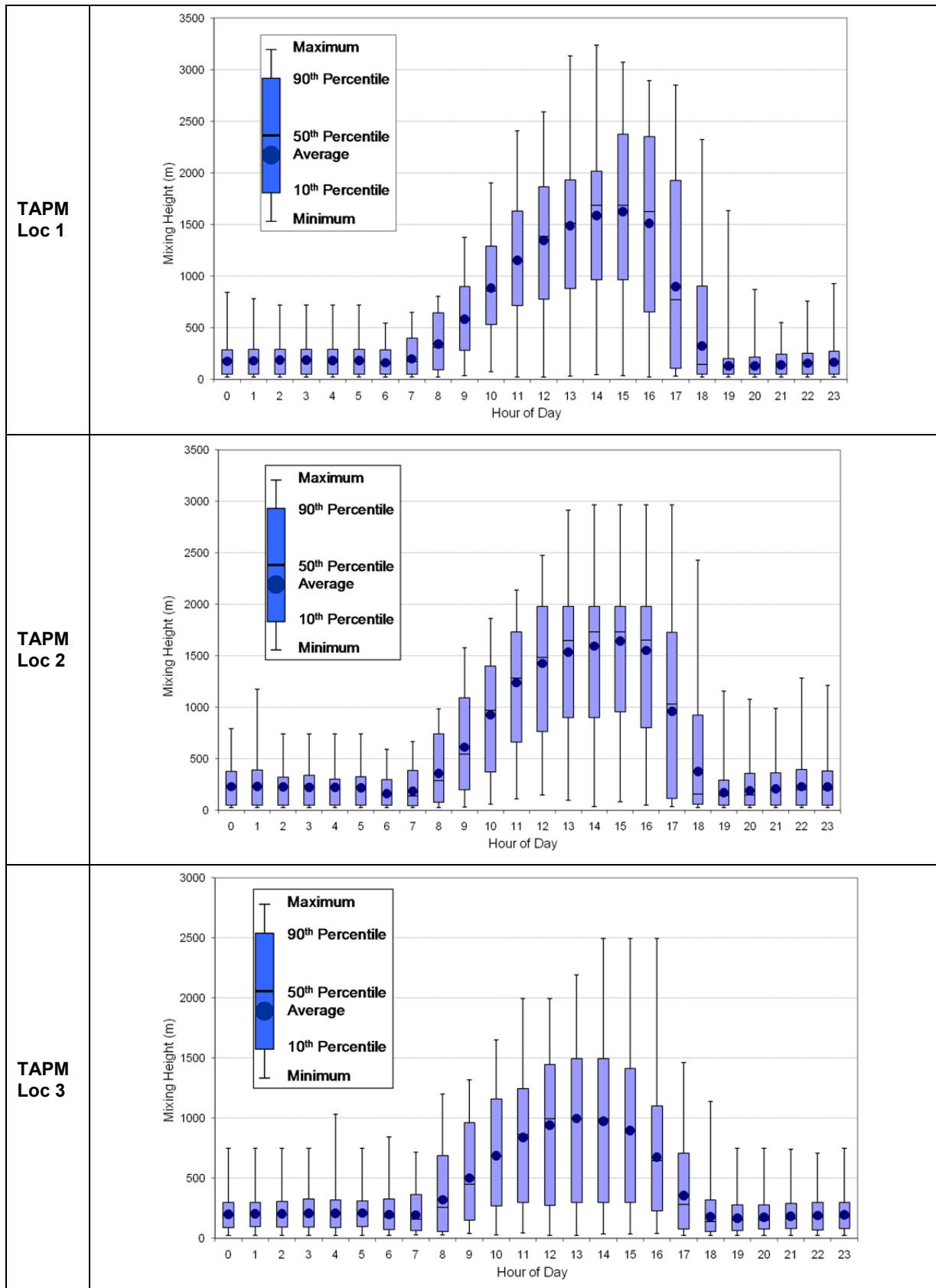


Figure 5.10 Mixing heights predicted by TAPM for the three locations (2009)

5.5.4 Terrain data and receptor locations

Because it is impossible to model all terrain types and configurations for a project such as this, which will move relatively quickly over a long distance, the modelling has been performed without consideration of terrain effects. To compensate for possible impacts of terrain on the predicted concentrations which have not been able to be accounted for in the modelling, a buffer of 25% was applied to all modelling results.

5.5.5 Emission estimation

Preliminary emissions estimation was completed for all sources listed in Table 5.3. A summary of the PM₁₀ emissions estimated for each operational scenario is provided in Figure 5.11. As shown in Figure 5.11, emissions for the rock exposure and blasting scenario, and the lowering and backfilling scenario were estimated to produce the greatest quantities of PM₁₀ emissions. This scenario was therefore chosen for further assessment using atmospheric dispersion modelling.

The modelling was performed to provide estimates of maximum downwind 24-hour PM₁₀ concentrations as well as annual average TSP, PM₁₀ and dust deposition rates. For the 24-hour averages, the modelling was performed based on the emissions occurring continuously for a 1-year period in order to ensure that all worst-case meteorological conditions are covered by the modelling.

However, in order to provide a realistic assessment of annual average impacts, the annual average concentrations have been derived from the model output based on the assumption that each of the construction activities would occur for only two days at any given location. This was done very conservatively, using the maximum predicted 24-hour concentrations for the worst case rock exposure and blasting scenario and assuming these concentrations occur for fourteen days (ie two days per construction stage, with seven stages). The annual average impact predicted for vehicle activity was then added. This is considered to be a very conservative approach given the expected 1.8 km per day progress rate for the construction activities and that not all scenarios would generate the peak level of dust emissions.

Details of the emission estimation calculations for the rock exposure and blasting scenario and the lowering and backfilling scenario are presented in the following section.

Emission factors for TSP and PM₁₀ have been sourced from the Commonwealth of Australia Document "National Pollutant Inventory (NPI) for Mining, Version 2.3 (2001)" and the US EPA's AP-42 Emission Factors where suitable factors do not exist within the NPI documentation. The emission factors used are presented in the following sections, which were derived using the assumptions discussed below.

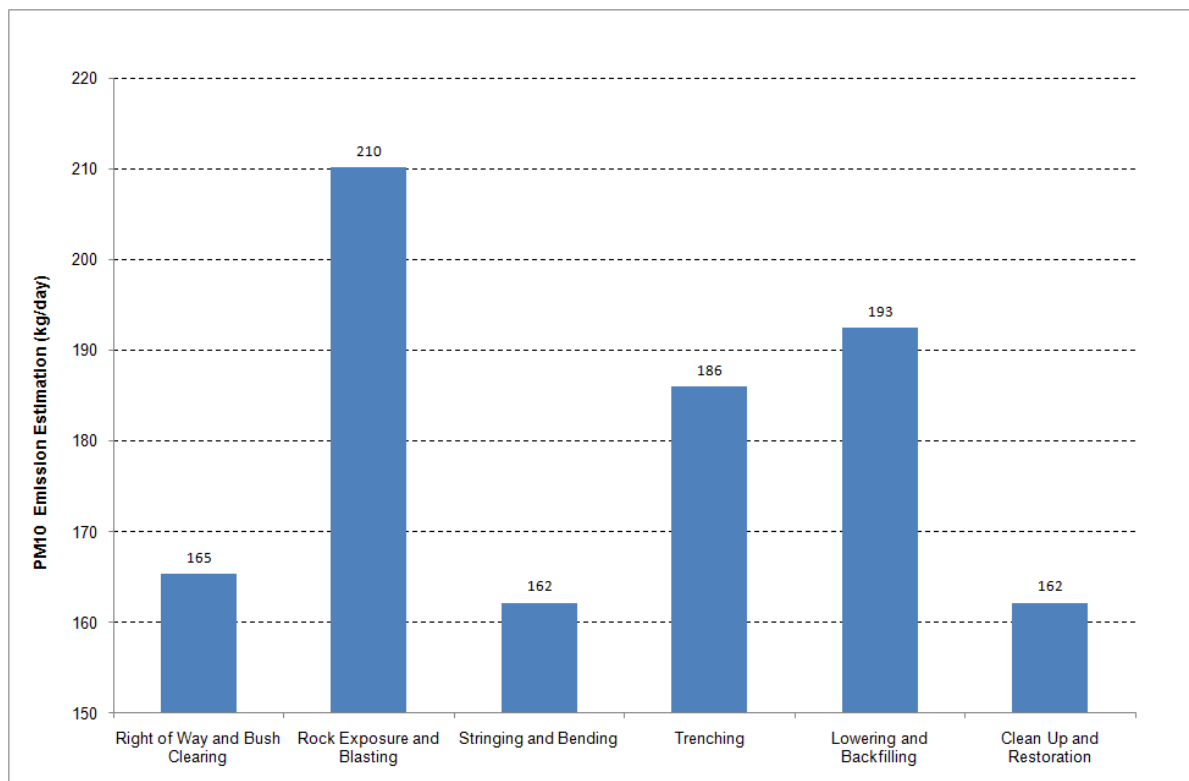


Figure 5.11 Summary of 24 hour maximum emission rates for each scenario

Assumptions

The construction scenario used in the assessment was based on the following assumptions.

- Work will be carried out 11 hours per day (6.30 am to 6.30 pm; taking into account a 1 hour break) and 365 days per year
- Stockpile dust (PM₁₀) emissions vary according to variable rates dependent upon wind speed
- Rock breaking will produce the same amount of dust (PM₁₀) emissions as drilling
- Work is anticipated to progressively move along the RoW; hence the entire section of RoW road will not be under full construction at any one time.
- All stockpiles were assumed to be located within the RoW area
- It was assumed that there will be a maximum of 25 vehicles servicing the site per hour. Each vehicle was assumed to be a truck with an assumed load capacity of 30 tonnes (t) and a mean gross weight of 50 t
- The hourly mass of excavated material is assumed to be 60 t per hour (40 m³ x 1.5 t/m³)
- It was assumed (as a worst case) that each haul truck traverses the entire section of the RoW access road, which was assumed to have a length of 5,000 m. Assuming 25 heavy vehicles travel up and down the road route each hour, this gives a distance travelled of 125 vehicle kilometres travelled per hour (VKT/hour)
- The unsealed RoW access road was assumed to have a silt content of 8.5% in accordance with US EPA (2006)
- A control factor of 72% was applied to the estimates of uncontrolled emissions from the RoW access road, which is based on water at rates of up to 2L/m²/hour and that speed is restricted to under 40 km/h on the RoW access road
- It is expected that a water truck will be used to wet the RoW access road surface and stockpiles to control dust during dry periods

Emissions from haul roads

All of the scenarios modelled included emissions from the RoW access road.

Emissions from the trucks travelling on the internal unpaved RoW access road have been estimated using the AP-42 equation derived emission factors as follows:

$$EF_{TSP} = 2.82 * (s/12)^{0.8} * (W/3)^{0.5} / (M/0.2)^{0.4} \text{ kg/VKT}$$

$$EF_{PM10} = 0.733 * (s/12)^{0.8} * (W/3)^{0.4} / (M/0.2)^{0.3} \text{ kg/VKT}$$

where:

- s = surface material silt content (%)
- W = vehicle gross mass (tonnes)
- M = surface material moisture content (%)
- kg/VKT = kg particulate per vehicle kilometre travelled

The parameters used in this assessment and resulting uncontrolled emission factors and emission rates are summarised in the table below.

Table 5.6 Estimation of emissions from Mainland GTP RoW access roads

Vehicles / Hour	EF – TSP kg/VKT	ER – TSP kg/annum total	EF - PM ₁₀ kg/VKT	ER - PM ₁₀ kg/annum total	EF – PM _{2.5} kg/VKT	ER – PM _{2.5} kg/annum total
25	1.46	187,050	0.39	49,432	0.039	4,943

Rock exposure and blasting scenario (for both RoW and accommodation camp)

Drilling and rock breaking

The emissions from drilling have been estimated using the NPI EETM default emission factor of 0.59 kg/hole for TSP and 0.31 kg/hole for PM₁₀ for 1 hole drilled/ hour.

Table 5.7 Estimation of emissions from drilling

Number of Drills	EF – TSP kg/hole	ER – TSP kg/annum/ drill	EF - PM ₁₀ kg/hole	ER - PM ₁₀ kg/annum/ drill	EF – PM _{2.5} kg/hole	ER – PM _{2.5} kg/annum/ drill
4	0.59	2,153.5	0.31	1,131.5	0.0465	169.7

As there were no emission factors for a backhoe with a hammer, the emissions were estimated using the drilling NPI EETM default factors as above and for 1 rock break/ hour.

Table 5.8 Estimation of emissions from rock breaking (using a backhoe with a hammer)

Number of backhoes (with hammer)	EF - TSP kg/hole	ER – TSP kg/annum/ backhoe	EF - PM ₁₀ kg/hole	ER - PM ₁₀ kg/annum/ backhoe	EF – PM _{2.5} kg/hole	ER – PM _{2.5} kg/annum/ backhoe
2	0.59	2,153.5	0.31	1,131.5	0.0465	169.7

Blasting

The emissions for blasting have been estimated using the NPI EETM emission factors as follows:

$$EF_{TSP} = 344 \times A^{0.8} \times M^{-1.9} \times D^{-1.8} \quad \text{kg/blast}$$

$$EF_{PM10} = EF_{TSP} \times 0.52 \quad \text{kg/blast}$$

where,

- EF = emission factor
- A = Blast Area
- M = Moisture content (%)
- D = Blast Hole Depth

For a blast area of 5 m², a moisture content of 7.9 % and a blast hole depth of 1.5 m, the emission factors and emission rates are calculated as shown below in Table 5.9.

Table 5.9 Estimation of Emissions from Blasting

Number of blasts/ hour	EF – TSP kg/blast	ER – TSP kg/annum (total)	EF - PM ₁₀ kg/blast	ER - PM ₁₀ kg/annum (total)	EF – PM _{2.5} kg/blast	ER – PM _{2.5} kg/annum (total)
1	11.8	4,307	6.16	2,248.4	0.923	336.9

Bulldozer

Emissions from the bulldozers in the pit were estimated using the NPI EETM factor for a bulldozer on overburden as follows:

$$EF_{TSP} = 2.6 * s^{1.2} / M^{1.3} \quad \text{kg/h}$$

$$EF_{PM10} = 0.34 * s^{1.5} / M^{1.4} \quad \text{kg/h}$$

where:

- s = silt content (%)
- M = surface material moisture content (%)

The parameters used in this assessment and resulting emission factors and emission rates are summarised in the table below using a silt content of 6.9 % and a moisture content of 7.9 %.

Table 5.10 Estimation of emissions from bulldozers

Number of Bulldozers	EF – TSP kg/hour	ER – TSP kg/annum (total)	EF - PM ₁₀ kg/hour	ER - PM ₁₀ kg/annum (total)	EF – PM _{2.5} kg/hour	ER – PM _{2.5} kg/annum (total)
1	1.8	6,570	0.341	1,244.7	0.189	186.9

Backhoe

Emissions from backhoe were estimated using the NPI EETM factor for a front end loader working on overburden as follows:

$$EF_{TSP} = 0.74 * 0.0016 * (U/2.2)^{1.3} / (M/2)^{-1.4} \quad \text{kg/tonne}$$

$$EF_{PM10} = 0.35 * 0.0016 * (U/2.2)^{1.3} / (M/2)^{-1.4} \quad \text{kg/tonne}$$

where:

- U = mean wind speed (m/s)

- M = surface material moisture content (%)

The parameters used in this assessment and resulting emission factors and emission rates are summarised in the table below using a mean wind speed of 2.4 m/s (from TAPM derived meteorological data) and a moisture content of 7.9 %.

Table 5.11 Estimation of emissions from backhoes

Number of Backhoes	EF – TSP kg/tonne	ER – TSP kg/annum (total)	EF - PM ₁₀ kg/tonne	ER - PM ₁₀ kg/annum (total)	EF – PM _{2.5} kg/tonne	ER – PM _{2.5} kg/annum (total)
1	0.000197	43.1	0.0000933	20.4	0.000014	3.1

Stockpiles

Emissions from wind erosion of the soil stockpiles were estimated using the default *NPI EETM for Mining* factors of 0.4 kg/ha/hr for TSP and 0.2 kg/ha/hr for PM₁₀ (NPI EETM for Mining, Table 1). Emissions were assumed to occur 24 hours per day varying according to wind speed.

The parameters used in this assessment and resulting emission factors and emission rates are summarised in the table below.

Table 5.12 Estimation of emissions from stockpiles

Number of Stockpiles	EF – TSP kg/year	ER – TSP kg/annum/ stockpile	EF - PM ₁₀ kg/year	ER - PM ₁₀ kg/annum/ stockpile	EF – PM _{2.5} kg/year	ER – PM _{2.5} kg/annum/ stockpile
6	0.4	1.75	0.2	0.88	0.03	0.13

Lowering and backfilling scenario

Bulldozer

Emissions from the bulldozers were estimated using the NPI EETM factor for a bulldozer on overburden (representative of a trenching operation) as follows:

$$EF_{TSP} = 2.6 * s^{1.2} / M^{1.3} \text{ kg/h}$$

$$EF_{PM10} = 0.34 * s^{1.5} / M^{1.4} \text{ kg/h}$$

where:

- s = silt content (%)
- M = surface material moisture content (%)

The parameters used in this assessment and resulting emission factors and emission rates are summarised in the table below using a silt content of 6.9 % and a moisture content of 7.9 %.

Table 5.13 Estimation of emissions from bulldozers

Number of Bulldozers	EF – TSP kg/hour	ER – TSP kg/annum/ bulldozer	EF - PM ₁₀ kg/hour	ER - PM ₁₀ kg/annum/ bulldozer	EF – PM _{2.5} kg/hour	ER – PM _{2.5} kg/annum/ bulldozer
6	1.8	6,570	0.341	1,244.7	0.189	186.9

Front end loader

Emissions from a front end loader were estimated using the NPI EETM factor for a front end loader working on overburden as follows:

$$EF_{TSP} = 0.74 * 0.0016 * (U/2.2)^{1.3} / (M/2)^{-1.4} \text{ kg/tonne}$$

$$EF_{PM10} = 0.35 * 0.0016 * (U/2.2)^{1.3} / (M/2)^{-1.4} \text{ kg/tonne}$$

where:

- U = mean wind speed (m/s)
- M = surface material moisture content (%)

The parameters used in this assessment and resulting emission factors and emission rates are summarised in the table below using a mean wind speed of 2.4 m/s (from TAPM derived meteorological data) and a moisture content of 7.9 %.

Table 5.14 Estimation of Emissions from front end loaders

Number of FEL	EF – TSP kg/hour	ER – TSP kg/annum/ FEL	EF - PM ₁₀ kg/hour	ER - PM ₁₀ kg/annum/ FEL	EF – PM _{2.5} kg/hour	ER – PM _{2.5} kg/annum/ FEL
7	0.000197	34.5	0.0000933	16.3	0.000014	2.5

Backhoe

Emissions from backhoe were estimated using the NPI EETM factor for a front end loader working on overburden (representative of trenching operations) as follows:

$$EF_{TSP} = 0.74 * 0.0016 * (U/2.2)^{1.3} / (M/2)^{-1.4} \text{ kg/tonne}$$

$$EF_{PM10} = 0.35 * 0.0016 * (U/2.2)^{1.3} / (M/2)^{-1.4} \text{ kg/tonne}$$

where:

- U = mean wind speed (m/s)
- M = surface material moisture content (%)

The parameters used in this assessment and resulting emission factors and emission rates are summarised in the table below using a mean wind speed of 2.4 m/s (from TAPM derived meteorological data) and a moisture content of 7.9 %.

Table 5.15 Estimation of emissions from backhoes

Number of Backhoes	EF – TSP kg/hour	ER – TSP kg/annum/ backhoe	EF - PM ₁₀ kg/hour	ER - PM ₁₀ kg/annum/ backhoe	EF – PM _{2.5} kg/hour	ER – PM _{2.5} kg/annum/ backhoe
8	0.000197	34.5	0.0000933	16.3	0.000014	2.5

Stockpiles

Emissions from wind erosion of the stockpiles were estimated using the default NPI EETM for Mining factors of 0.4 kg/ha/hr for TSP and 0.2 kg/ha/hr for PM₁₀ (NPI EETM for Mining, Table 1). Emissions were assumed to occur 24 hours per day varying according to wind speed.

The parameters used in this assessment and resulting emission factors and emission rates are summarised in the table below.

Table 5.16 Estimation of emissions from stockpile

Number of Stockpiles	EF – TSP kg/year	ER – TSP kg/annum (total)	EF - PM ₁₀ kg/year	ER - PM ₁₀ kg/annum (total)	EF – PM _{2.5} kg/year	ER – PM _{2.5} kg/annum (total)
1	0.4	1,892.2	0.2	946.1	0.03	141.9

5.5.6 Source layout

All sources identified in Table 5.3 for the dust scenarios modelled, rock exposure and blasting, and lowering and backfilling were evenly spaced across a 5 km stretch of the 30 m wide RoW. They were modelled as volume sources except for the RoW access road which was modelled as a line source. A stockpile was also modelled in the lowering and backfilling scenario that stretched along a 5 km section of the Mainland GTP RoW. This was also modelled as a line source.

The modelling configuration as set out by the CALPUFF ‘Key Variable Field Extraction Module’ is detailed below for the lowering and backfilling scenario.

Table 5.17 CALPUFF model switch options

	MGAUSS	MSLUG	MCHEM	MAQCHEM	MWET	MDRY	MTILT	MDISP	MDISP2	MPDF	MTURBYW	MTAULY	MTAUADV	MCTURB	MROUGH	MBDW	MTRANS	MTIP	MSHEAR	MPARTL	MTINV	MCTADJ	MCTSG	MSPLIT	MSGTIBL	MBCON	MSOURCE	MFOG	MREG
1	0	0	0	0	0	1	0	2	3	0	3	1	1	1	0	1	1	1	0	1	0	3	0	0	0	0	0	0	0

Table 5.18 CALPUFF source details

	Mean	Mean	Release	Base	Sigma	Sigma	TSP	PM ₁₀	PM _{2.5}
Source	X	Y	Height	Elev	Y	Z	Rate	Rate	Rate
	km	km	m	m(MSL)	m	m	kg/h	kg/h	kg/h
Backhoe	999.11	999.992	4	0	4.65	1	4.00E-03	2.00E-03	3.00E-04
Bulldozer	999.17	1000.007	4	0	11.63	1	7.50E-01	1.41E-01	7.90E-02
FEL	999.239	999.992	4	0	4.65	1	4.00E-03	2.00E-03	3.00E-04
Backhoe	999.326	1000.006	4	0	4.65	1	4.00E-03	2.00E-03	3.00E-04
Backhoe	999.417	1000.001	4	0	4.65	1	4.00E-03	2.00E-03	3.00E-04
FEL	999.516	999.991	4	0	4.65	1	4.00E-03	2.00E-03	3.00E-04
Bulldozer	999.609	1000.008	4	0	11.63	1	7.50E-01	1.41E-01	7.90E-02
Bulldozer	999.723	999.993	4	0	11.63	1	7.50E-01	1.41E-01	7.90E-02
FEL	999.826	1000.005	4	0	4.65	1	4.00E-03	2.00E-03	3.00E-04
Backhoe	999.934	999.991	4	0	4.65	1	4.00E-03	2.00E-03	3.00E-04
FEL	1000.082	1000.006	4	0	4.65	1	4.00E-03	2.00E-03	3.00E-04
Bulldozer	1000.176	999.992	4	0	11.63	1	7.50E-01	1.41E-01	7.90E-02
Bulldozer	1000.267	1000.008	4	0	11.63	1	7.50E-01	1.41E-01	7.90E-02
FEL	1000.35	999.992	4	0	4.65	1	4.00E-03	2.00E-03	3.00E-04
Backhoe	1000.447	999.999	4	0	4.65	1	4.00E-03	2.00E-03	3.00E-04
Backhoe	1000.55	1000.007	4	0	4.65	1	4.00E-03	2.00E-03	3.00E-04
Bulldozer	1000.642	999.992	4	0	11.63	1	7.50E-01	1.41E-01	7.90E-02
FEL	1000.727	1000.008	4	0	4.65	1	4.00E-03	2.00E-03	3.00E-04
Backhoe	1000.809	999.992	4	0	4.65	1	4.00E-03	2.00E-03	3.00E-04
Backhoe	1000.888	1000.007	4	0	4.65	1	4.00E-03	2.00E-03	3.00E-04
FEL	1000	1000	4	0	4.65	1	4.00E-03	2.00E-03	3.00E-04

5.6 Potential adverse or beneficial impacts on air quality (construction and operation)

5.6.1 Modelling results

Dispersion modelling predictions of dust deposition rates and ambient TSP and PM₁₀ concentrations at distances from the GTP attributable to the Mainland GTP and accommodation camp construction works are presented in Section 5.6.2 to Section 5.6.4.

When interpreting these modelling results it is important to understand that the results presented represent worst case impacts from the construction activity added to a near worst case background concentration. For these predicted cumulative concentrations to occur in reality, it would require that elevated background concentrations and the worst case meteorological conditions that give rise to the maximum predicted impacts from the construction activities both occur at the same time during the period that the construction activities are also aligned with the sensitive receptors identified in a worst case manner. This is not expected to occur frequently and therefore the real impacts from the GTP activities are likely to be much less than those presented in the following sections. Therefore the results in the following sections merely highlight those sections of the Mainland GTP where additional care must be taken with pollutant emission mitigation measures to ensure that there are no impacts on the nearest sensitive receivers.

5.6.2 Dust deposition

Figure 5.12 presents the incremental annual average monthly dust deposition rates (in $\text{mg}/\text{m}^2/\text{day}$) predicted by the dispersion model for the rock exposure and blasting scenario for the accommodation camps and the Mainland GTP and the lowering and backfilling scenario for the Mainland GTP. As discussed in Section 5.5.5, these modelling results are based on the assumption that the activities would occur for only two days at any given location due to the expected 1.8 km per day progress rate for the construction activities

The results indicate that annual average dust deposition rates at all locations surrounding the Mainland GTP RoW and the accommodation camps are predicted to meet the adopted guideline of $120 \text{ mg}/\text{m}^2/\text{day}$ (cumulative dust deposition). Dust deposition rates greater than $120 \text{ mg}/\text{m}^2/\text{day}$ are often associated with potential nuisance dust issues. It is therefore recommended that when operating near businesses or sensitive receiving environments, appropriate dust controls measures (such as those presented Section 5.8) are employed.

Given that the construction activities on the Mainland GTP are expected to progress at a rate of approximately 1.8 km per day, it is not recommended that any monitoring for dust deposition be conducted during the construction works. Dust deposition monitoring is performed based on a 30 ± 2 day monitoring period, and the results would not be available from the laboratory for at least a week after the sampling period is finished. Hence any compliance issue arising from a particular construction activity identified from the monitoring will have already moved on from the problem area.

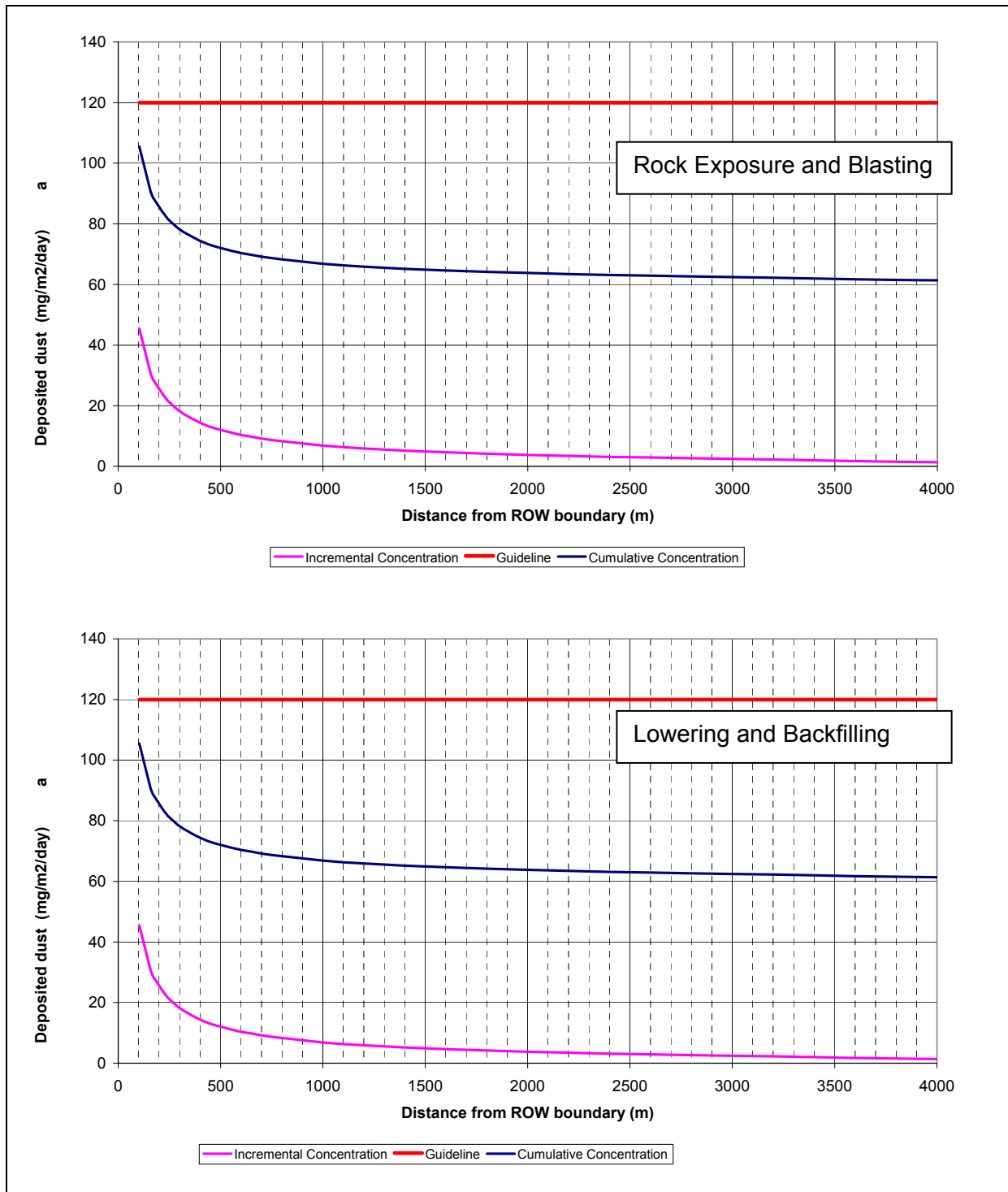


Figure 5.12 Predicted annual average dust deposition rate versus distance from the Mainland GTP section

5.6.3 TSP

Figure 5.13 presents the annual average TSP concentrations (in $\mu\text{g}/\text{m}^3$) predicted by the dispersion model for the rock exposure and blasting for the accommodation camps and the Mainland GTP, and the lowering and backfilling construction scenarios for the Mainland GTP RoW. As discussed in Section 5.5.5, these modelling results are based on the assumption that the activities would occur for only two days at any given location due to the expected 1.8 km per day progress rate for the construction activities.

The results indicate that annual average TSP concentrations at all locations are predicted to meet the adopted annual average TSP guideline of $90 \mu\text{g}/\text{m}^3$. At all locations the annual average TSP concentrations are predominantly related to the background concentration of $30 \mu\text{g}/\text{m}^3$ assumed in this study. The incremental impacts predicted by the modelling at this distance from the construction area are $30 \mu\text{g}/\text{m}^3$ for the Rock Exposure and Blasting scenario and $31 \mu\text{g}/\text{m}^3$ for the Lowering and Backfilling construction scenario.

Employment of good dust management practices such as those presented in Section 5.8 will minimise impact that the construction of the Mainland GTP RoW may cause.

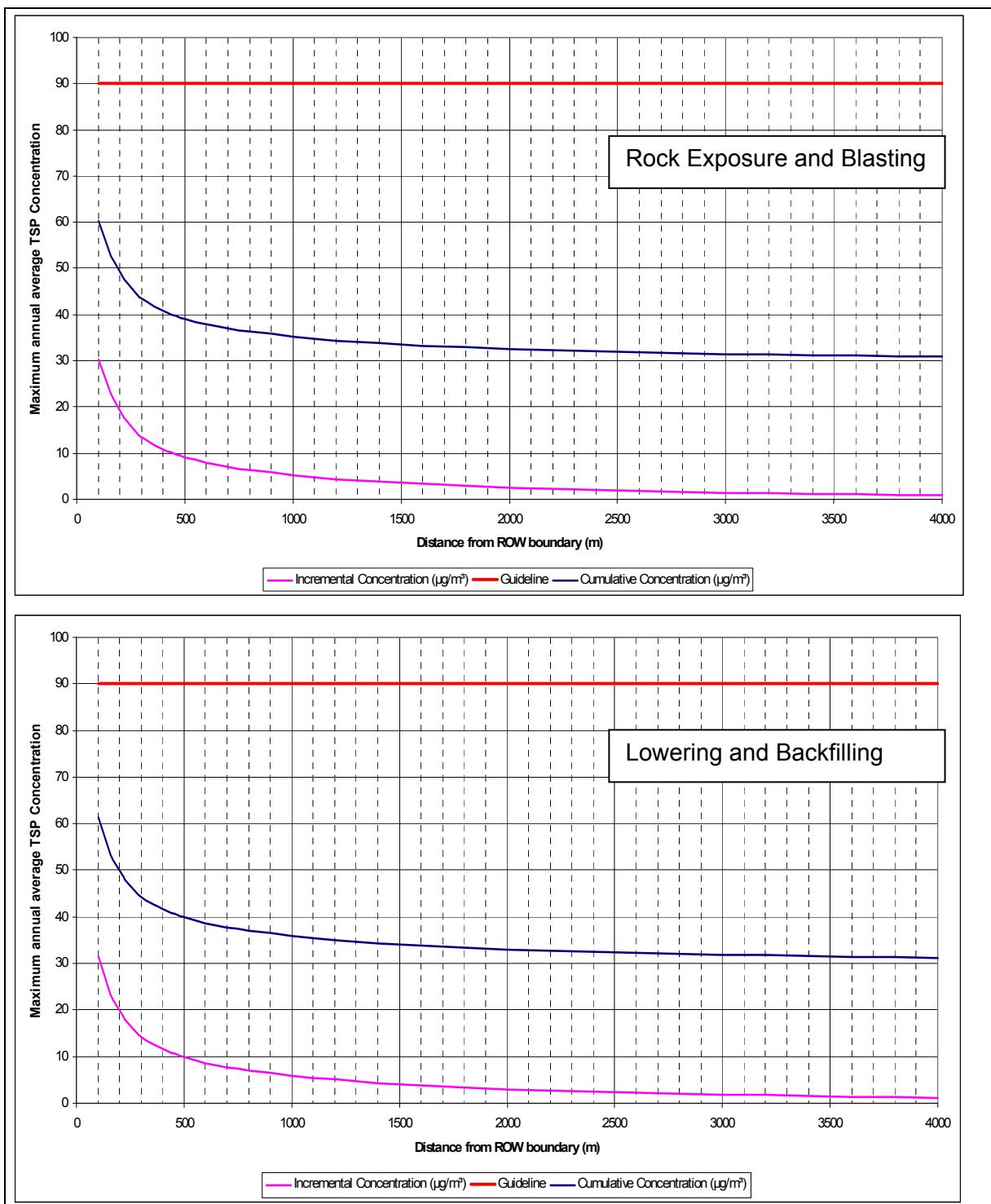


Figure 5.13 Maximum predicted annual average TSP concentrations ($\mu\text{g}/\text{m}^3$) versus distance from the Mainland GTP

5.6.4 PM10

Figure 5.14 presents the 24-hour average PM₁₀ concentrations (in $\mu\text{g}/\text{m}^3$) predicted by the dispersion model for the rock exposure and blasting for the accommodation camps and the Mainland GTP and lowering and backfilling construction scenarios for the Mainland GTP. The results are presented as incremental impacts and as cumulative impacts including the background PM₁₀ concentrations discussed in Section 5.4.2.

The results indicate that 24-hour average PM₁₀ concentrations at locations closer than 350 m to the Mainland GTP RoW and the accommodation camps construction works may exceed the adopted 24 hour average PM₁₀ guideline of 50 µg/m³. However, this is predominantly related to the background concentration of 30 µg/m³ assumed in this study; the incremental impacts predicted by the modelling at this distance from the construction area of 16 µg/m³ for the lowering and backfilling construction scenario (affecting the Mainland GTP only), and 20 µg/m³ for the rock exposure and blasting construction scenario. As mentioned earlier for these concentrations to occur relies on worst case meteorology occurring simultaneously with high background concentrations, at the same time as the construction activity is occurring in the vicinity of the receptor and that the construction activity is occurring at the conservatively high rates assumed for this study. The likelihood of all of these conditions occurring at the same time is very low and therefore the real likelihood of exceedence of these guidelines is low.

Employment of good dust management practices such as those presented in Section 5.8 will minimise impact that the construction of the accommodation camps and the Mainland GTP RoW may cause. These discussions assume contemporaneous peak background concentrations with peak site emissions at closest proximity to the receptors.

Of the receptors identified, those that might potentially be affected by PM₁₀ concentrations higher than the adopted guidelines are listed in Table 5.19.

Contour plots of the potential impacts at these receptors from peak 24 hour PM₁₀ concentrations are presented in Figure 5.15 to Figure 5.22.

Table 5.19 Receptors potentially affected by PM₁₀ emissions

ID	UTM easting (m)	UTM northing (m)	Distance to source (m)	Type	24 hr average PM ₁₀ concentration (µg/m ³)	
					Incremental	Cumulative
53	811130	7302389	103	R	50	80
147	904089	7343059	159	R	39	69
54	811078	7302099	170	R	37	67
193	915636	7367080	218	R	27	57
4	688087	7164695	224	CR	26	56
43	778065	7290787	243	R	25	55
175	910420	7362892	290	R	23	53
200	917511	7366955	318	C	22	53
127	875127	7318903	320	R	22	52
209	918884	7366716	329	R	22	52
167	908159	7361195	367	R	20	50
76	846761	7309966	373	R	20	50

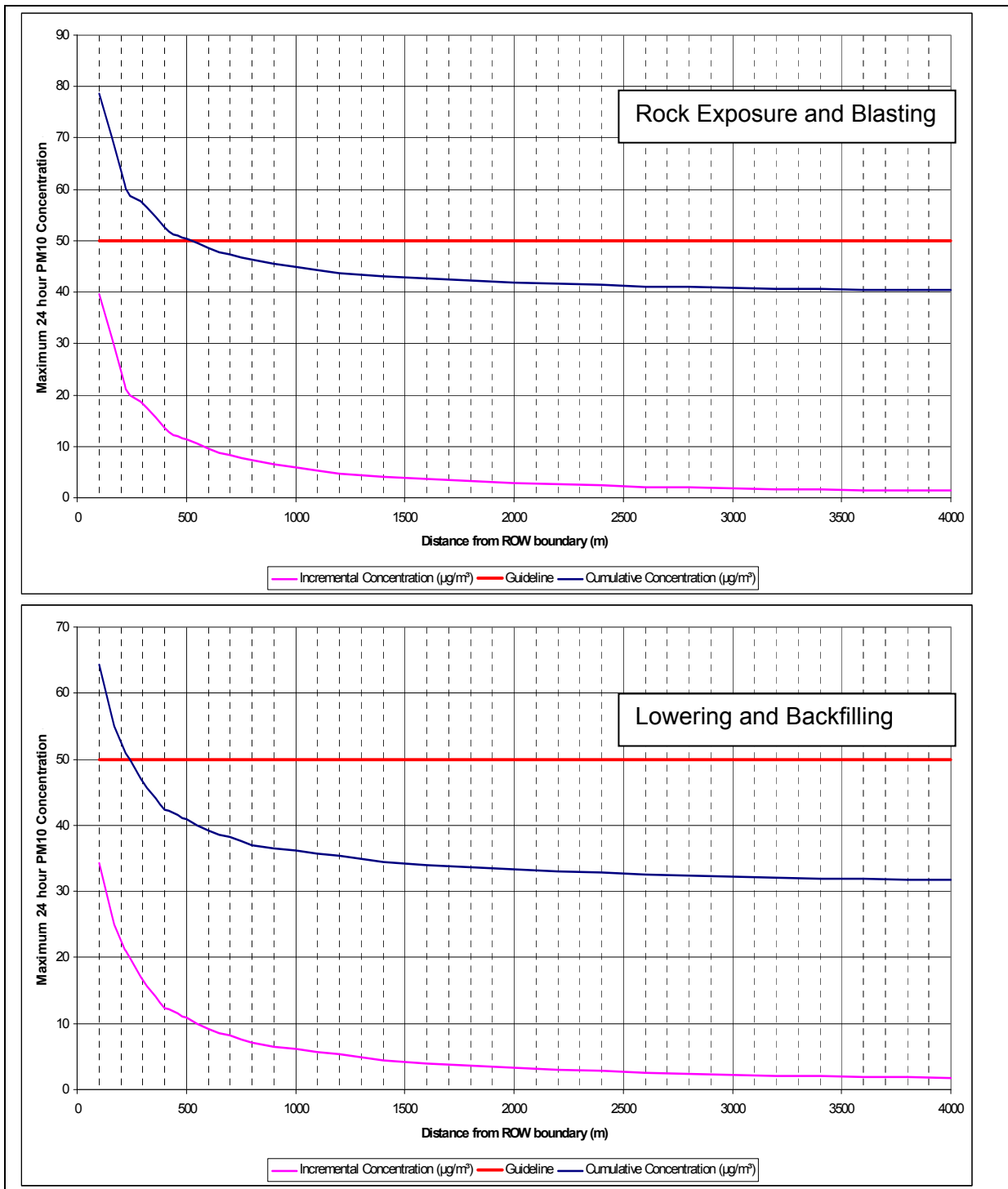


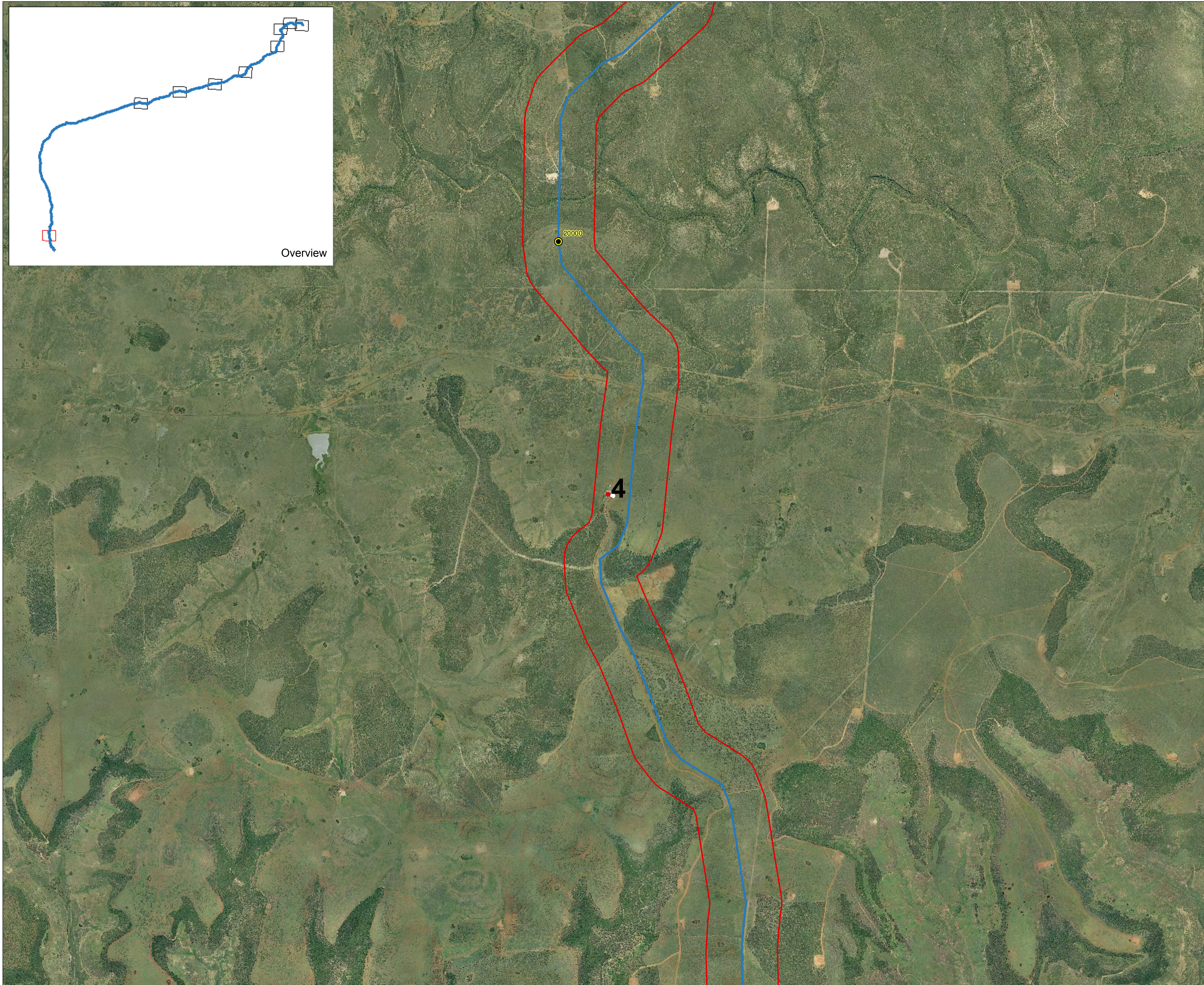
Figure 5.14 Maximum predicted 24 hour average PM₁₀ concentrations versus distance from the Mainland GTP



Mainland GTP EM Plan

Legend

- Towns
 - Industrial Receivers
 - Sensitive Receivers
 - Pipeline
 - Potential peak 24 hour average PM10 concentrations ($\mu\text{g}/\text{m}^3$)
- Kilometre Post Distance Marker**
- 50 50km
 - 10 10km

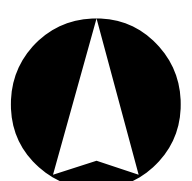


Source:
Kilometre Post Distance Marker - Santos, 2010
Pipeline - SLR, 2011 derived from Santos 2010
Industrial Receivers - SLR, 2011
Sensitive Receivers - SLR, 2011
Potential peak 24 hour average PM10 concentrations ($\mu\text{g}/\text{m}^3$) - SLR, 2011
Aerial Image EQ_Arcadia_Fairview_Photo_2010.ecw, Santos 2011.

**Potential peak 24 hour average
PM10 concentrations ($\mu\text{g}/\text{m}^3$)**

Figure 5.15

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Map by: MR



A1 scale: 1:20,000
0 250 500 750 1,000 1,250m

GLNG No:
Coordinate system: MGA Zone 55

Date: 15/03/2011

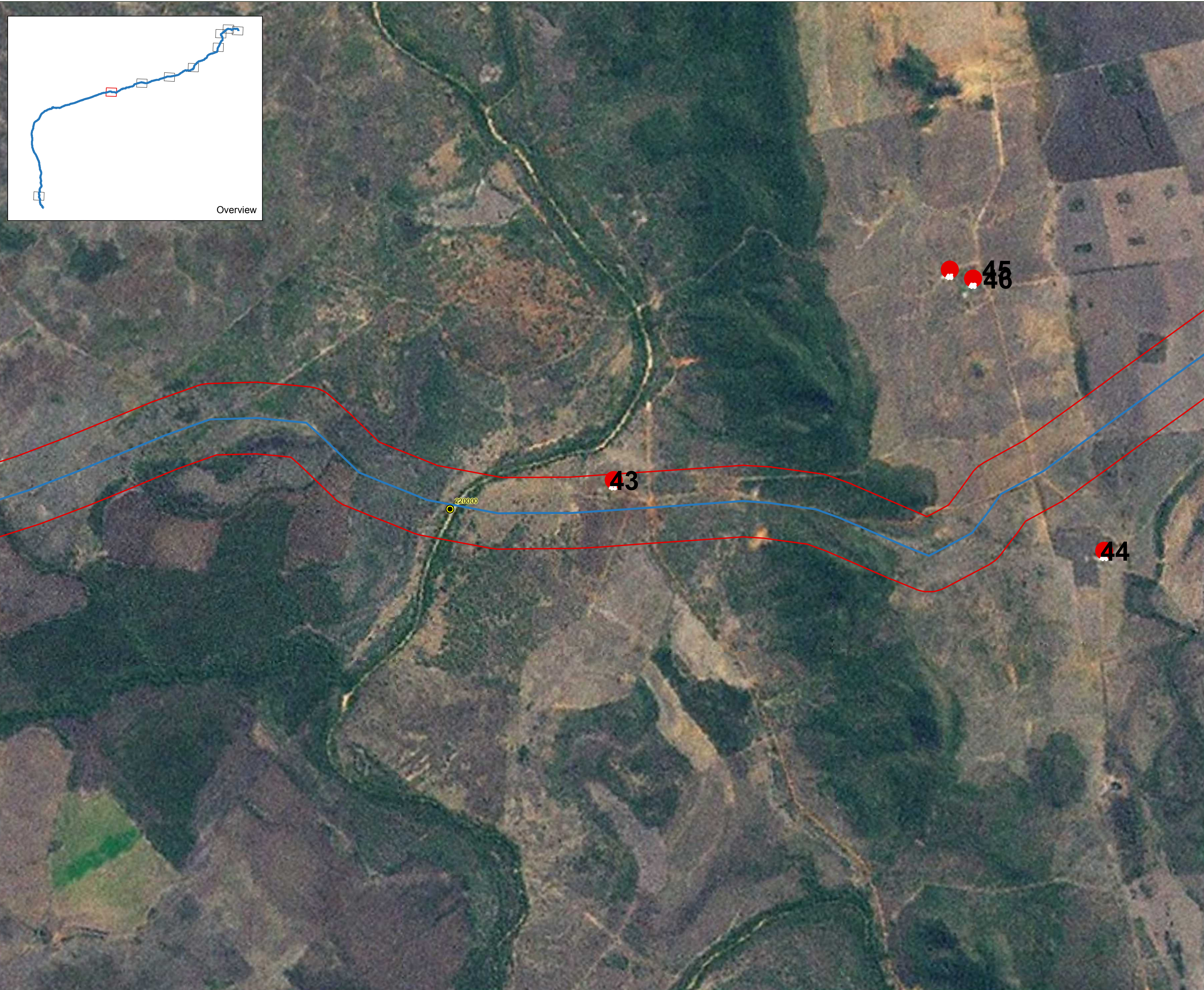
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Mainland GTP EM Plan

Legend

- Towns
 - Industrial Receivers
 - Sensitive Receivers
 - Pipeline
 - Potential peak 24 hour average PM10 concentrations ($\mu\text{g}/\text{m}^3$)
- Kilometre Post Distance Marker**
- 50km
 - 10km



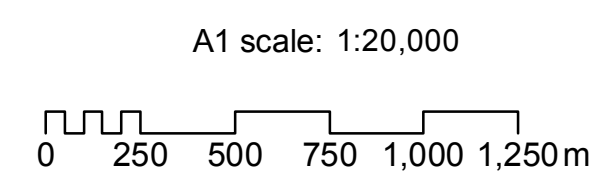
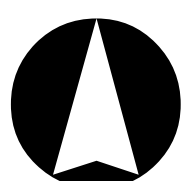
Source:
 Kilometre Post Distance Marker - Santos, 2010
 Pipeline - SLR, 2011 derived from Santos 2010
 Industrial Receivers - SLR, 2011
 Sensitive Receivers - SLR, 2011
 Potential peak 24 hour average PM10 concentrations ($\mu\text{g}/\text{m}^3$) - SLR, 2011
 Aerial Image: Esri Image Web Service, 2011

**Potential peak 24 hour average
PM10 concentrations ($\mu\text{g}/\text{m}^3$)**

Figure 5.16

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Map by: MR



GLNG No:
 Coordinate system: MGA Zone 55

Date: 15/03/2011

Version1



Mainland GTP EM Plan

Legend

- Towns
 - Industrial Receivers
 - Sensitive Receivers
 - Pipeline
 - Potential peak 24 hour average PM10 concentrations ($\mu\text{g}/\text{m}^3$)
- ### Kilometre Post Distance Marker
- 50km
 - 10km

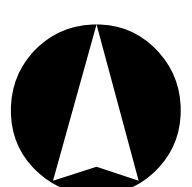


Source:
Kilometre Post Distance Marker - Santos, 2010
Pipeline - SLR, 2011 derived from Santos 2010
Industrial Receivers - SLR, 2011
Sensitive Receivers - SLR, 2011
Potential peak 24 hour average PM10 concentrations ($\mu\text{g}/\text{m}^3$) - SLR, 2011
Aerial Image: Esri Image Web Service, 2011

**Potential peak 24 hour average
PM10 concentrations ($\mu\text{g}/\text{m}^3$)**

Figure 5.17

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Map by: MR



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GLNG No:
Coordinate system: MGA Zone 55

Date: 15/03/2011

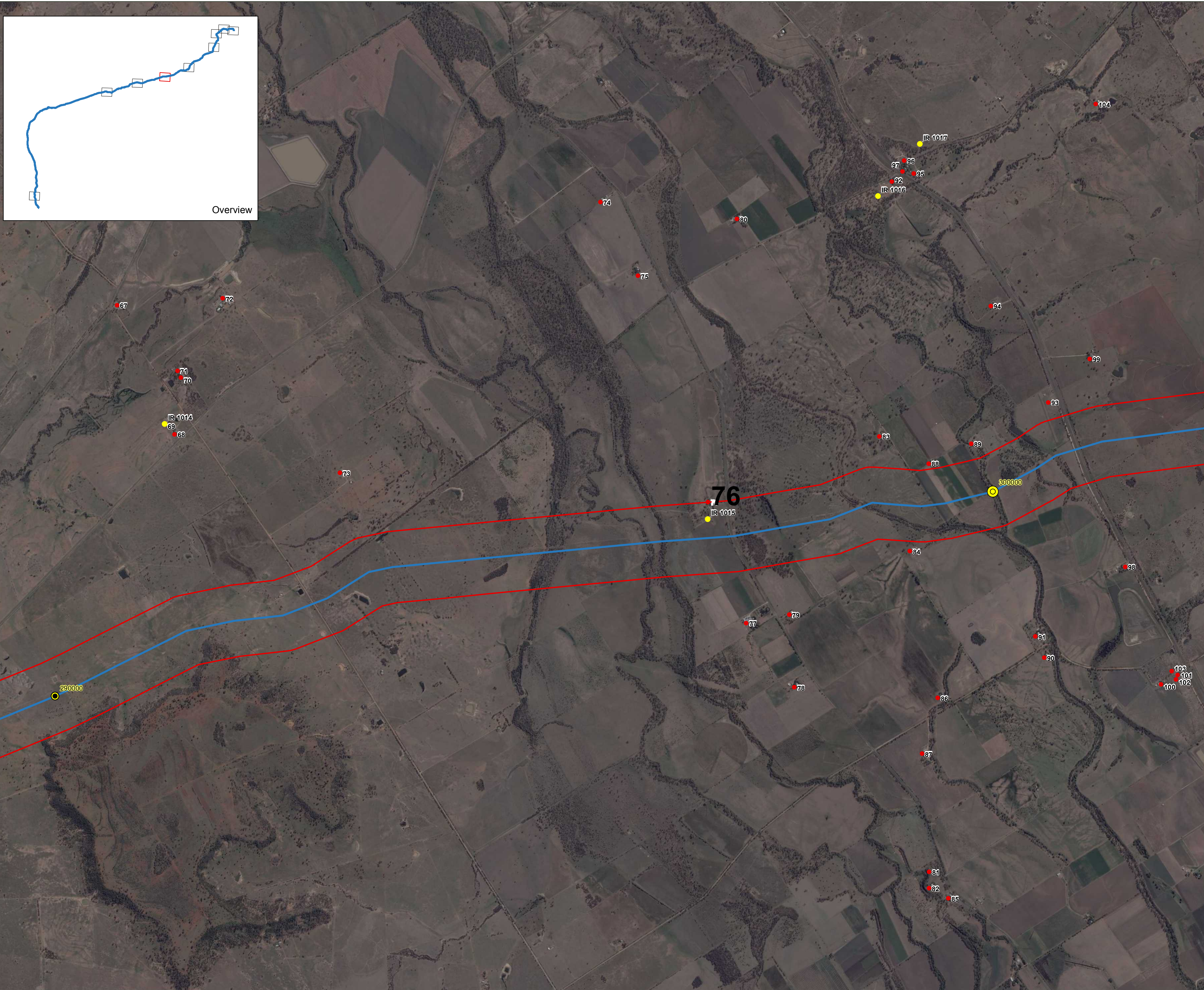
Version1



Mainland GTP EM Plan

Legend

- Towns
 - Industrial Receivers
 - Sensitive Receivers
 - Pipeline
 - Potential peak 24 hour average PM10 concentrations ($\mu\text{g}/\text{m}^3$)
- Kilometre Post Distance Marker**
- 50km
 - 10km

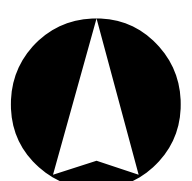


Source:
 Kilometre Post Distance Marker - Santos, 2010
 Pipeline - SLR, 2011 derived from Santos 2010
 Industrial Receivers - SLR, 2011
 Sensitive Receivers - SLR, 2011
 Potential peak 24 hour average PM10 concentrations ($\mu\text{g}/\text{m}^3$) - SLR, 2011
 Aerial Image: Esri Image Web Service, 2011

Potential peak 24 hour average PM10 concentrations ($\mu\text{g}/\text{m}^3$)

Figure 5.18

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Map by: MR



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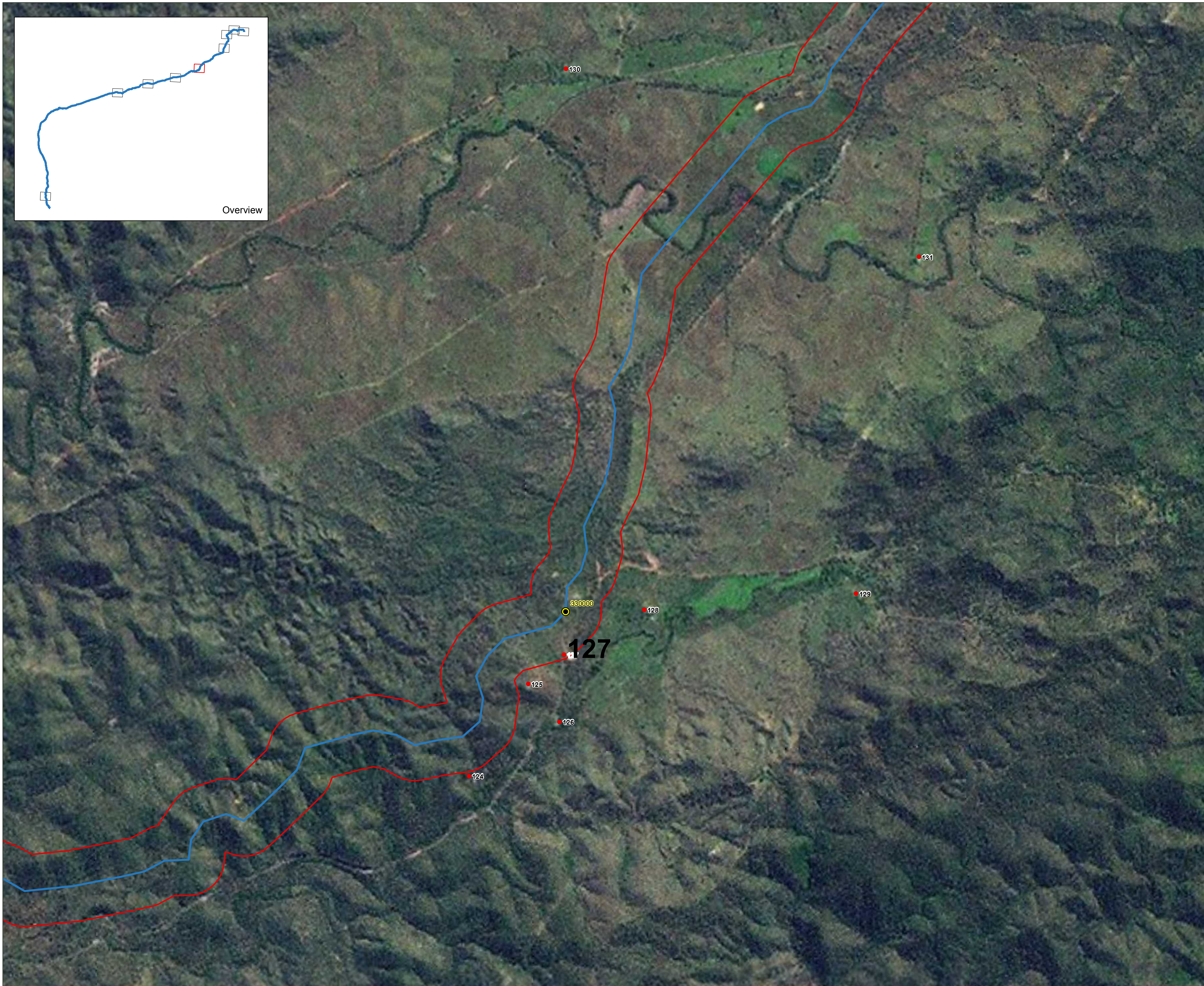
GLNG No:
 Coordinate system: MGA Zone 55



Mainland GTP EM Plan

Legend

- Towns
 - Industrial Receivers
 - Sensitive Receivers
 - Pipeline
 - Potential peak 24 hour average PM10 concentrations ($\mu\text{g}/\text{m}^3$)
- Kilometre Post Distance Marker**
- 50km
 - 10km

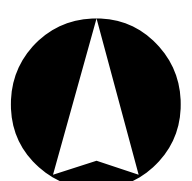


Source:
 Kilometre Post Distance Marker - Santos, 2010
 Pipeline - SLR, 2011 derived from Santos 2010
 Industrial Receivers - SLR, 2011
 Sensitive Receivers - SLR, 2011
 Potential peak 24 hour average PM10 concentrations ($\mu\text{g}/\text{m}^3$) - SLR, 2011
 Aerial Image: Esri Image Web Service, 2011

**Potential peak 24 hour average
PM10 concentrations ($\mu\text{g}/\text{m}^3$)**

Figure 5.19

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Map by: MR



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GLNG No:
Coordinate system: MGA Zone 55

Date: 15/03/2011

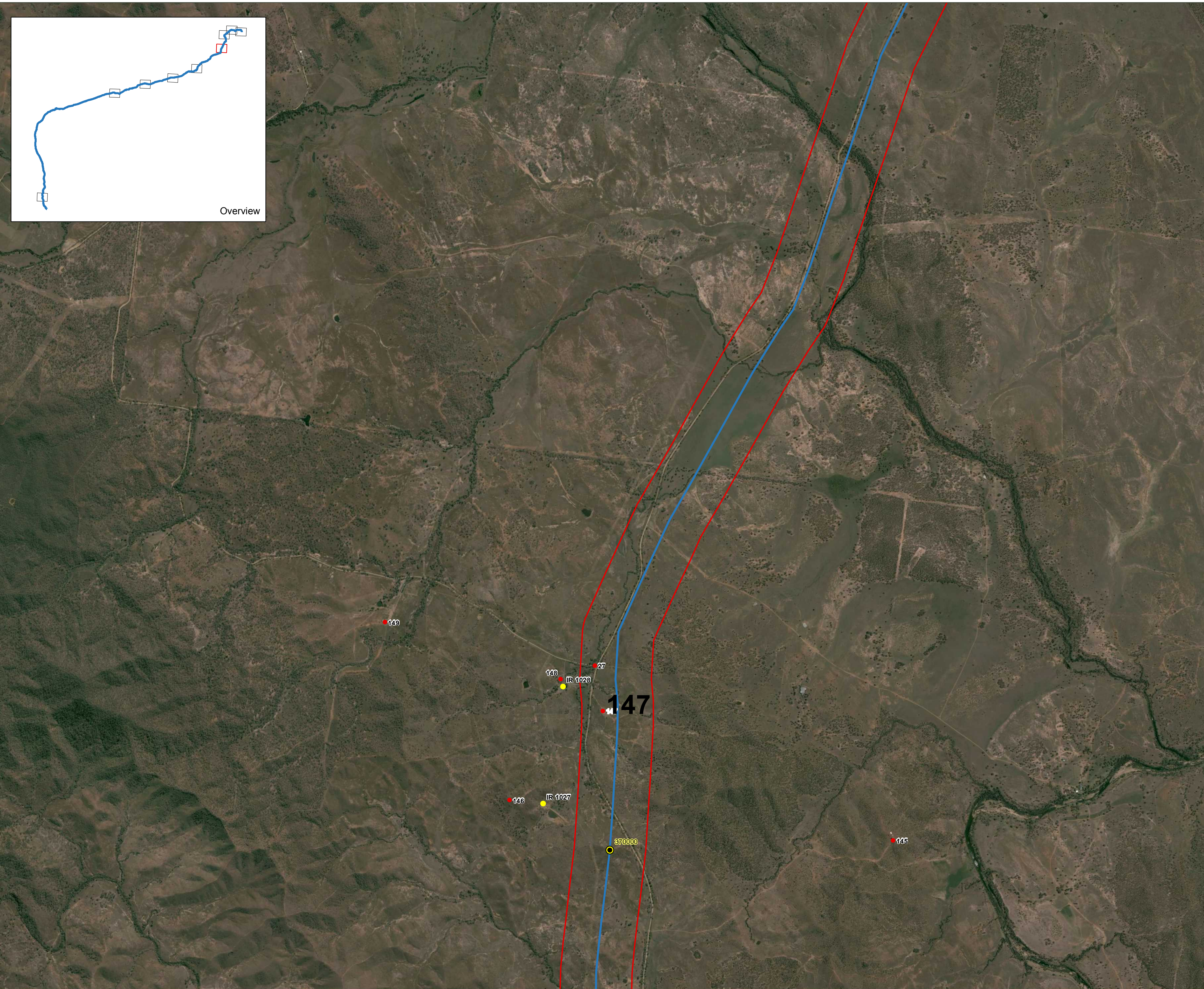
Version1



Mainland GTP EM Plan

Legend

- Towns
 - Industrial Receivers
 - Sensitive Receivers
 - Pipeline
 - Potential peak 24 hour average PM10 concentrations ($\mu\text{g}/\text{m}^3$)
- Kilometre Post Distance Marker**
- 50km
 - 10km



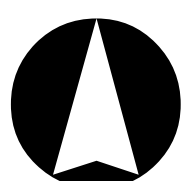
Source:
 Kilometre Post Distance Marker - Santos, 2010
 Pipeline - SLR, 2011 derived from Santos 2010
 Industrial Receivers - SLR, 2011
 Sensitive Receivers - SLR, 2011
 Potential peak 24 hour average PM10 concentrations ($\mu\text{g}/\text{m}^3$) - SLR, 2011
 Aerial Image: Esri Image Web Service, 2011

**Potential peak 24 hour average
PM10 concentrations ($\mu\text{g}/\text{m}^3$)**

Figure 5.20

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Map by: MR



A1 scale: 1:20,000

GLNG No:
 Coordinate system: MGA Zone 55

Date: 15/03/2011

Version1



Mainland GTP EM Plan

Legend

- Towns
 - Industrial Receivers
 - Sensitive Receivers
 - Pipeline
 - Potential peak 24 hour average PM10 concentrations ($\mu\text{g}/\text{m}^3$)
- Kilometre Post Distance Marker**
- ⊙ 50km
 - ⊙ 10km



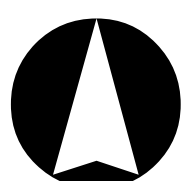
Source:
 Kilometre Post Distance Marker - Santos, 2010
 Pipeline - SLR, 2011 derived from Santos 2010
 Industrial Receivers - SLR, 2011
 Sensitive Receivers - SLR, 2011
 Potential peak 24 hour average PM10 concentrations ($\mu\text{g}/\text{m}^3$) - SLR, 2011
 Aerial Image: Esri Image Web Service, 2011

**Potential peak 24 hour average
PM10 concentrations ($\mu\text{g}/\text{m}^3$)**

Figure 5.21

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Map by: MR



A1 scale: 1:20,000

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Date: 15/03/2011

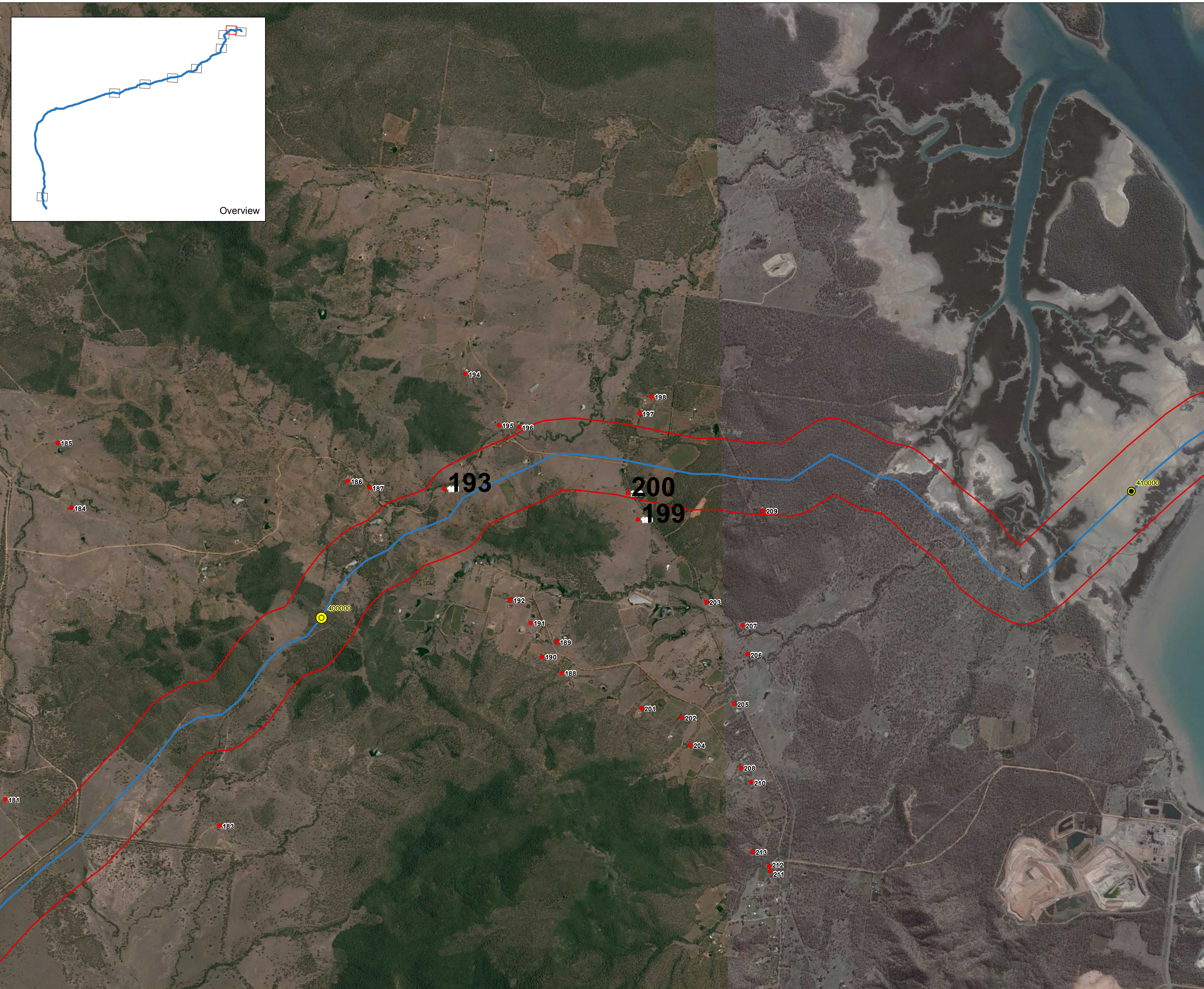
Version1



Mainland GTP EM Plan

Legend

- Towns
 - Industrial Receivers
 - Sensitive Receivers
 - Pipeline
 - Potential peak 24 hour average PM10 concentrations ($\mu\text{g}/\text{m}^3$)
- Kilometre Post Distance Marker**
- 50km
 - 10km



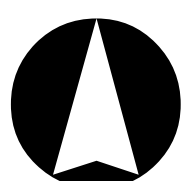
Source:
 Kilometre Post Distance Marker - Santos, 2010
 Pipeline - SLR, 2011 derived from Santos 2010
 Industrial Receivers - SLR, 2011
 Sensitive Receivers - SLR, 2011
 Potential peak 24 hour average PM10 concentrations ($\mu\text{g}/\text{m}^3$) - SLR, 2011
 Aerial Image: Esri Image Web Service, 2011

**Potential peak 24 hour average
PM10 concentrations ($\mu\text{g}/\text{m}^3$)**

Figure 5.22

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Map by: MR



A1 scale: 1:20,000
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GLNG No:
 Coordinate system: MGA Zone 55

Date: 15/03/2011

Version1

5.6.5 Summary of impacts of construction and operation

Construction

Dispersion modelling of the construction and operations of the Mainland GTP RoW and accommodation camps indicates that some sensitive receptors are likely to be impacted by the pollutants investigated. Despite this, it is recommended that the mitigation methods presented in Section 5.8 be adopted to minimise potential air quality impacts at unidentified sensitive locations and to protect the health of workers involved in the construction project.

A number of sensitive receivers have been identified as being at risk of having the 24 hour PM₁₀ guidelines exceeded. While construction work is undertaken in the vicinity of these receptors, extra attention will be paid to dust mitigation activities. This would include increasing the frequency of watering of haul roads and access track within the RoW and limit construction activities during periods of high wind speeds.

Operation

Monthly inspections will be carried out along the Mainland GTP RoW by vehicle and foot patrols to check on the condition of the GTP and associated infrastructure. Typically maintenance on the Mainland GTP RoW will be carried out by light vehicles and small maintenance crews on an annual basis, or as and when required.

Air quality impacts from these operational activities are expected to be acceptable and manageable due to the low number of vehicle movements, infrequent maintenance activities and separation distances from the Mainland GTP RoW to the sensitive receptors.

Furthermore, all activities and works associated with these operational activities will be in accordance with the OMP. The OMP will be developed prior to construction and implemented in all stages of the project, including construction, operation and decommissioning.

5.7 Greenhouse gas assessment

Greenhouse gas (GHG) emissions for the GTP have been inventoried and assessed as a component of the GHG assessment for the GLNG Project. This section provides an overview of the GTP GHG assessment.

The GTP has been addressed as a whole rather than being split into three sections (i.e. Mainland, Marine Crossing and Curtis Island), as the GHG emissions from the shorter sections associated with the Marine Crossing and Curtis Island represent a very small (and immaterial) component of the GTP (and Project) greenhouse gas emissions profile and do not warrant separate assessment.

Methodology

The GHG emissions inventory has been prepared in accordance with the methodology set out in *The Greenhouse Gas Protocol: a Corporate Accounting and Reporting Standard* (The Protocol), the relevant emissions factors in the National Greenhouse Accounts (NGA) Factors (November 2008), the *Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2006 – Energy (Fugitive Fuel Emissions)* and the Intergovernmental Panel on Climate Change Good Practice Guidance.

The main GHGs emitted during project activities (exhaust fumes) will be carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O). To report these emissions, they have been converted to carbon dioxide equivalents (CO₂-e) using their global warming potential, as detailed in the NGA Factors. Construction activities associated with the GTP will result in the emission of CO₂ and trace amount of N₂O from diesel combustion in stationary and mobile engines. Trace amounts of methane may be emitted from vegetation stockpiles. Operational emissions of GHG's will be from vehicles involved in inspection and maintenance (mostly CO₂). Methane is not likely to be released during the operational phase.

The Protocol defines direct and indirect emissions through the concept of emission “scopes”:

- *Scope 1 – Direct GHG Emissions* are produced as a direct result of activities that constitute a facility controlled by a company (eg emissions from combustion in boilers or vehicles, fugitive emissions and emissions from on-site power generators) or directly associated with an operational activity
- *Scope 2 – Electricity Indirect GHG Emissions* arise from purchased electricity, heat or steam
- *Scope 3 – Other Indirect GHG Emissions* are emissions that occur outside the boundary of a facility as a result of activities at the facility. This is an optional reporting class that accounts for all other indirect GHG emissions resulting from a company's activities but occurring from sources not owned or controlled by the company. Examples include transportation of products and end use of sold products and services

Emission sources

Scope 1 GHG emissions for the GTP arise from land clearing and the on-site consumption of diesel fuel in construction equipment and vehicles during construction.

Scope 2 emissions arise from electricity purchased for the temporary construction camps during construction of the GTP.

Scope 3 emissions during GTP construction are due to transport of construction materials in vehicles not owned or controlled by the GLNG Project.

GHG emissions during operation of the GTP are assumed to be immaterial, as the GTP will be fully welded, there will be no regular process emissions and compression of the gas will be carried out at the coal seam gas field facilities (i.e. there are no compressor stations on the GTP itself).

Carbon sequestration due to the rehabilitation of cleared areas has not been included in the inventory, this provides a worst case assessment of emissions (i.e. the estimate of greenhouse gas presented in this assessment is highly conservative).

Emission factors

Emission factors have been used to estimate GHG emissions, in accordance with the Protocol.

Emission factors for the carbon loss associated with land clearing along the GTP RoW were obtained using the FullCAM model, from the Department of Climate Change's National Carbon Accounting Toolbox, in combination with data on vegetation types obtained from vegetation studies of the GTP RoW. A value of 36.7 t C/ha (135 t CO₂-e/ha) was calculated by modelling several points along the GTP with representative types and amounts of vegetation and averaging the results.

Emission factors used to calculate GHG emissions for diesel combustion, electricity consumption and freighting of equipment by rail have been sourced from the Department of Climate Change NGA Factors Workbook, 2008 and the Queensland Rail Greenhouse Challenge Cooperative Agreement 2000. These are shown in Table 5.20.

Table 5.20 Emission factors used in the GHG inventory for the pipeline

Emission Source	Emission Factor				Units
	CO ₂	CH ₄	N ₂ O	Total	
Scope 1 – Diesel combustion	2.67	0.01	0.02	2.7	t CO ₂ -e/KL
Scope 2 – Electricity Consumption (Queensland)	-	-	-	0.91	kg CO ₂ -e/kWh
Scope 3 – Transport of freight by rail	-	-	-	0.26	g CO ₂ -e/net tonne km

- No emission factors exist

Estimated emissions

A summary of Scope 1 and Scope 2 emissions for the entire GTP is provided in Table 5.21. The calculation of emissions from diesel combustion during construction assumed a construction period of 21 months, with a 6 month ramp-up / ramp-down period with activity rates 50% of that occurring during the main construction period (15 months). Activity rates for the main construction period assumed a workforce of 1,000 workers and construction equipment of 100 heavy vehicles operating 10 hours per day.

Worst case assumptions have been incorporated in calculating carbon loss associated with land clearing (i.e. complete clearance of an easement for the 420 km length (Mainland, Marine Crossing and Curtis Island) of the GTP, and vegetation of the entire RoW characterised by vegetation types that are present close to the main watercourses) which result in a conservative estimate of the GHG emissions.

Table 5.21 Total Scope 1 and Scope 2 Greenhouse Gas Emissions for the Pipeline (tonnes CO₂-e)

Emissions Source	Scope 1 Emissions	Scope 2 Emissions
Construction Equipment	2,962	0
Land Clearing	171,588	0
Accommodation	0	4,095
Total	174,550	4,095

Scope 3 emissions have been investigated and estimated for the GLNG project as a whole. It is noted that Scope 3 emissions are not routinely reported by companies because emissions are difficult to estimate accurately, the company does not have effective control of the emission sources and they will be reported elsewhere by a another entity as their Scope 1 emissions.

Table 5.22 outlines indicative estimates of Scope 3 emissions for construction and transport for the GLNG Project for two scenarios, encompassing an option using rail to deliver materials to the temporary pipe storage areas along the GTP RoW.

Table 5.22 Total GLNG Project Scope 3 Emissions from Construction and Transport (tonnes CO₂-e)

Scenario	Scope 3 Emissions
No rail	17,850
Rail	19,415

Impacts

GHG emissions from the GTP component form a small part of the total GHG emissions profile for the GLNG Project and are relatively small in comparison to state and national emissions. The estimated annual Scope 1 emissions from the GTP over the 21 month construction period represent approximately 0.05% of Queensland's annual emissions (2008 data) and less than 0.02% of Australian annual emissions (2006 data). The impact of GLNG project GHG emissions in the context of the regulatory framework and state and national emissions and targets are further discussed in the EIS (Section 6.9.5).

Greenhouse Gas Management Strategy

Climate change is a global issue requiring significant resources to meet complex environmental, energy, economic and political challenges. As a global stakeholder in the energy business, GLNG Operations recognises that one of its most important environmental responsibilities is to pursue strategies that address the issue of GHG emissions.

In accordance with the CG Report, Condition 4 in Appendix 1 Part 1 of the Coordinator-General's evaluation report for the GLNG project) a GHG reduction strategy will be implemented for the project and submitted to the Coordinator-General for approval. The foundation for the strategy will be the Climate Change Policy and the Climate Change Management Standard under the Environment Health and Safety Management System. The Climate Change Policy embodies commitments to reduce the carbon intensity of GTP construction and operation by focusing on energy efficiency, technology development, embedding a carbon price in all activities and continuing public emissions reporting.

The key components addressed by the GHG reduction strategy will be:

- Design and construction of assets (development)
- Energy efficiency and continuous improvement (operations)
- Measurement and reporting of GHG emissions

The philosophy of design applied to the GLNG Project explicitly requires that environmental considerations, including maximising energy efficiency and minimising GHG emissions, are given priority in the design of the GLNG Project. The requirements include quantitative guidelines and general qualitative goals. All equipment to be installed must be compared against best-practice performance to ensure that the most up-to-date technologies are used. As a result, opportunities to reduce GHG emissions and improve energy efficiency have been (and will continue to be) identified and incorporated into the design, as outlined in Section 6.9.5.5 of the EIS. The majority of these opportunities relate to the LNG facility; opportunities to reduce GHG emissions from the GTP are more limited and relate principally to minimising land clearing, the use of fuel efficient equipment and operational procedures to minimise gas releases. These pipeline specific measures are listed in Section 5.4.

GLNG Operations is committed to actively pursuing energy efficiency and has registered an energy efficiency assessment and reporting schedule with the federal government which meets its obligations under the *Energy Efficiency Opportunities Act 2006*. This approach will be applied to the GLNG Project. Under this approach, detailed energy assessments are conducted across GLNG Operations works on a five year program cycle. An Energy Efficiency Opportunities Report is included in the annual Sustainability Report. Energy efficiency initiatives include an annually reviewed energy loss/reduction project, the development of energy efficiency plans with site-specific targets, transport reduction plan and incorporation of energy utilisation and evaluation component in purchasing procedures.

Climate change performance will be reported and disclosed according to legislative requirements and numerous voluntary commitments, including:

- Publication of emissions profile on the GLNG website and Annual and Sustainability Reports
- Energy Efficiency Opportunities program
- Reporting under the *National Greenhouse and Energy Reporting Act 2007*
- International Carbon Disclosure Project

GLNG Operations emissions inventory is subject to voluntary assurance by independent auditors in accordance with Australian Auditing and Assurance Standard ASAE 3000 *Assurance Engagements Other than Audits or Reviews of Historical Financial Information*.

Appropriate emission and inventory databases are maintained to meet these reporting requirements.

5.8 Cumulative impacts

Cumulative impacts on air quality and climate change are outlined below. This cumulative impact assessment is based on the impact scope, identification and scoring methodology described in Chapter 2 of this EM Plan. Air emissions from the construction of the Mainland GTP and accommodation will consist primarily of dust and combustion pollutants. Potential sources of air emissions include the clear and grade of vegetation and soil, trenching and vehicle/machinery movements. The RoW will generally be in remote locations with a buffer distance to the nearest sensitive receptors and therefore will result in minor, short term impacts. In regard to greenhouse gas emissions no cumulative (i.e. more than additive) impact is predicted.

5.8.1 Air quality (emissions from vehicles)

Air emissions may be generated from exhausts of construction vehicles and other machinery, such as generators etc. The generation of emissions that may reduce local and regional air quality is considered to be an additive impact. However, it is unlikely that these sorts of emissions will combine to exceed air quality objectives except in an extremely localised and short term manner.

Assuming the implementation of measures in the project EM Plans there will be negligible cumulative impacts on air quality.

5.8.2 Air quality (dust impacts on human receptors)

In general there are few residential receptors close to the RoW in the Callide Infrastructure Corridor and Gladstone State Development Area corridors (Northern Infrastructure Corridor and Western Corridor). Population density in this area ranges from 0 to 7 people per km² (EIS March 2009). Population density is higher around the Gladstone area, ranging from 46 to 179 people per square km.

The largest concentrations of settlements potentially affected by cumulative dust impacts are along the NIC, in the vicinity of Targinnie Mount Larcom and Callide, which primarily consists of rural properties. Approximately 20 homesteads are present within or in close vicinity to the CIC and GSDA corridors, particularly between the Calliope River and Callide. These properties are potentially exposed to dust emissions from the construction site.

The primary source of air emissions from the construction of the Mainland GTP and accommodation camps will be from dust generated by vegetation clearance, earthworks,

loose material stockpiling and vehicle movements. Other sources of dust emissions will occur from other construction activities associated with ancillary works. Dust emissions may lead to:

- Nuisance issues for neighbouring receptors.
- Impacts from settlement of dust on areas of irrigated horticulture in the vicinity of Targinnie and Mount Larcom.

Prevailing south easterly winds will carry dust away from sensitive receptors in Targinnie.

Cumulatively, dust nuisance impacts to human receptors could be intensified by overlapping construction activities that result in increased overall dust levels, or prolonged where the construction programs do not overlap.

Increased dust emissions may cause potential cumulative impacts to cultivated areas adjacent to the GTP corridors (particularly close to Targinnie, Mount Larcom and Callide). Each project will need to strictly manage dust levels to minimise deposition on vegetation in adjacent vegetation communities. Suitable management of dust through individual EM Plans should effectively mitigate this. There will be minor negative cumulative impacts on air quality.

5.8.3 Greenhouse gas

Greenhouse gas (GHG) emissions may be produced by the following activities:

- Construction vehicle movements on site.
- Creation of vegetation waste.
- Disturbance to existing land use.
- Construction plant equipment.

Total GHG emissions are simply additive and will not increase from the levels already assessed for each project, even if projects are constructed at the same time.

If construction timeframes do overlap, there may be some opportunities for combining activities between projects such that GHG emissions are reduced and there is a positive cumulative impact, however in the context of the overall projects, these are not likely to be significant unless implemented across all of the projects. There will be negligible cumulative greenhouse gas emissions.

5.9 Environmental protection commitments, objectives and control strategies – air quality (construction and operation)

Control measures for the minimisation of particulate emissions from various construction activities are outlined in this section. To provide information on the relative significance of the various sources associated with the construction activities in terms of their potential to generate dust emissions, the estimated emission rates for the various sources in the rock exposure and blasting, and the lowering and backfilling scenarios have been plotted in Figure 5.23. These graphs clearly show that the haul roads are by far the largest dust source for both stages of the works, hence mitigation measures should focus on this source.

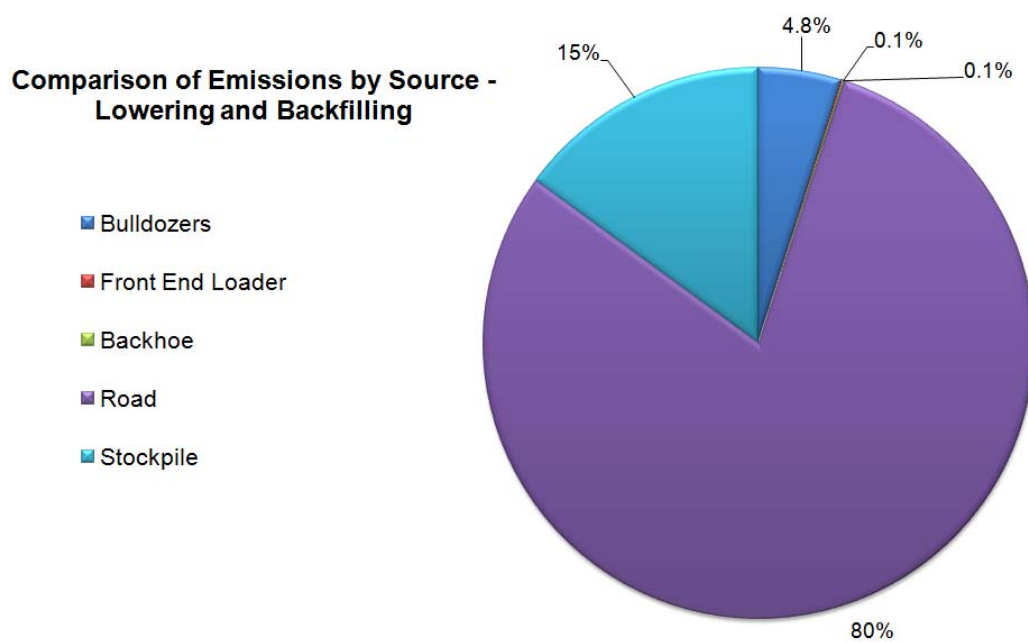
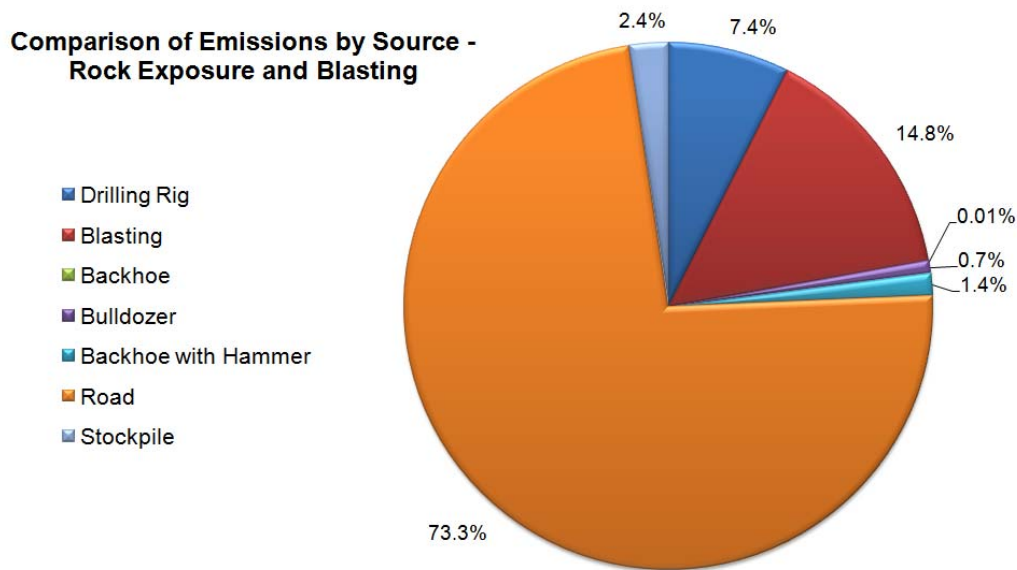


Figure 5.23 Comparative source contributions
 Environmental protection commitments, objectives and control strategies proposed in relation to air are presented in Table 5.23.

Table 5.23 Environmental protection commitments, objectives and control strategies – air quality

Item	Detail
Environmental protection objective	<ul style="list-style-type: none"> To construct and install the pipeline in a manner that does not significantly affect the values of the air environment
Specific objectives	<ul style="list-style-type: none"> No warranted complaints from landholders, and warranted complaints responded to within 2 working days No excessive dust emissions during construction of the GTP The release of odour, dust or any other airborne contaminant(s), or light from the petroleum activity must not cause an environmental nuisance at any sensitive place or commercial place
Control strategies	<p>Pre construction phase</p> <ul style="list-style-type: none"> GLNG Operations will develop and implement a greenhouse gas reduction strategy for the project. The strategy must include, but not be limited to, GLNG Operations policy on greenhouse gas emissions, an energy efficiency program, a continuous improvement program, better control systems and a CO₂ recovery plan. The strategy must be submitted to the Coordinator-General for approval within three months of the granting of the petroleum facilities licence for the LNG facility <p>Construction phase</p> <ul style="list-style-type: none"> Consult with and advise any landholders with the potential to be impacted by temporary construction dust emissions prior the commencement of activities Vehicles and machinery will be fitted with appropriate exhaust systems and emission control devices. The devices will be maintained in good working order Construction sites and access roads will be watered on an as required basis to minimise the potential for environmental nuisance due to dust. Watering frequency will be increased during periods of high risk (eg high winds) The extent and period of exposure of bare surfaces will be minimised The disturbed corridor will be promptly restored following construction to stabilise the disturbed surface and limit the potential for dust generation Vehicle speeds will be controlled within the RoW A “no burning” policy for cleared vegetation will be implemented Ensure excessive dust deposition does not occur on the foliage of significant plants and ecological communities adjacent the disturbance footprint and affect the plants ability to photosynthesise The release of odour, dust or any other airborne contaminant(s), or light from the petroleum activity must not cause an environmental nuisance at any sensitive place or commercial place. Sensitive or commercial place is any Residential Dwelling, School, University, Child Care Facility, Hospital or commercial place within 500 m of the pipeline corridor The Contractor is to provide to GLNG Operations for approval, a Sustainability Management Plan (Sustainability MP) that includes specific criteria and deliverables that will demonstrate how a high performance for all sustainability indicators for the design and construction of the proposed Pipeline will be achieved. This plan should include appropriate chapters or sub plans regarding energy efficiency and greenhouse gas emissions including site-specific targets <p>Operational phase</p> <ul style="list-style-type: none"> Typical mitigation and controls for the operational phase of the Project will be detailed in the Operational Management Plan, which will be developed prior to construction
Performance indicators	<ul style="list-style-type: none"> Complaints responded to within 2 working days No excessive dust emissions during construction of the Mainland GTP

6. Dams

6.1 Proposed temporary storage dam works

Pipeline integrity will be verified by hydrotesting. During the hydrotesting process the pipe will be filled with water. The pipeline once capped and filled is then pressurised and a 24-hour leak test follows. The water from hydrotesting will be reused along the length of the Mainland GTP where possible. Hydrotest water will be transferred from one test section to another via a series of valves.

For hydrotesting works to be undertaken, water volumes at a rate of approximately 1,000 m³/hr will be required to be pumped into the pipeline. To ensure that an adequate water supply is available to be able pump at such a high rate, it is proposed to construct up to four temporary water storage dams (herein after referred to as dams) at approximately 100 km intervals and within 100 – 200 m of the pipeline prior to commissioning.

The total volume of water required for the hydrotesting process is approximately 360,000 m³. This water will be sourced from approved water extraction sources. Dams will be sealed to comply with appropriate civil engineering standards (e.g. through the use of a liner) to prevent any contamination and to provide a barrier to seepage. The size of each dam will be determined by the availability of land size and the approved quantity of water that can be extracted from the local source. Dams capable of storing up to 100,000 m³ of water may be required. Figure 6.1 below shows the possible locations of water sources along the pipeline route, with the typical layout of a dam illustrated in Figure 6.2.

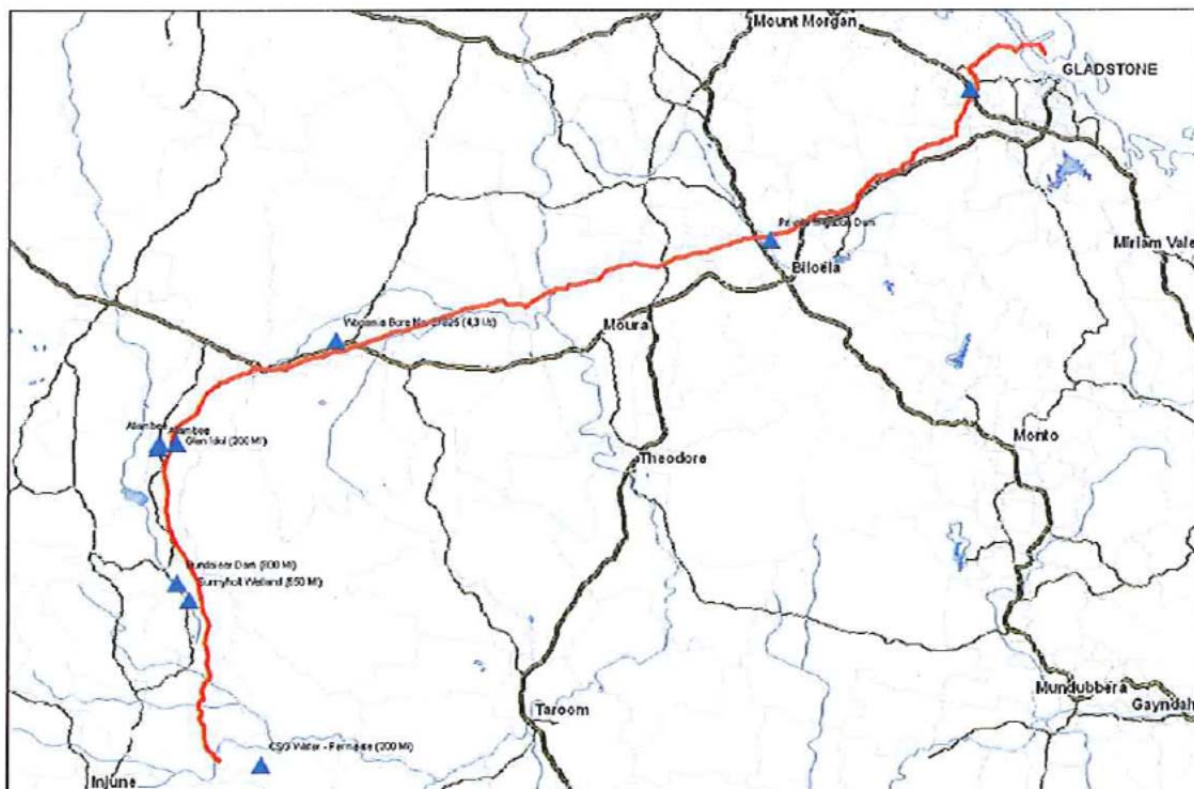


Figure 6.1 Location of main water sources along the GTP

6.2 Description of environmental values

Based on the proposed works described above, construction, operation and decommissioning of the four dams has the potential to impact on environmental values, including land, flora and fauna, and water.

In the case of land, the environmental values that may be impacted upon consist of geology, topography, geomorphology, soils, terrain units, good quality agricultural land (GQAL), strategic cropping land, salinity, erosion potential, sodicity, and reactive soils. A full description of each of these values along the Mainland GTP RoW is provided in Chapter 7.

Flora and fauna environmental values that may be affected by the construction, operation and decommissioning of the dams include flora and their associated habitats, fauna and their associated habitats, and regional ecosystems. A full description of the flora and fauna environmental values along the Mainland GTP RoW is provided in Chapter 9.

The water related environmental values that may be impacted upon are those associated with surface water drainage lines, wetlands, springs, groundwater and aquifers. A full description of these water related environmental values is provided in Chapter 14.

6.3 Potential adverse or beneficial impacts of project activities of identified environmental values (construction and operation)

The potential impacts associated with the construction, operation and decommissioning of the dams on land, flora and fauna, and water related environmental values are discussed below.

6.3.1 Impacts on land attributes

The construction of the dams is not expected to have significant impacts on geology. There will be a reasonable degree of flexibility with respect to siting these particular dams and consideration of land values during siting can be used to mitigate the risk of harm to environmental values.

Potential impacts to topography include changes to gradients as a result of excavation and levelling of ground to support construction of the dams. Any impacts to topography are expected to be minor as the siting consideration for these dams can limit potential impacts to low and manageable levels.

Soil erosion and generation of sediment present a slightly higher risk as the soils within the vicinity of the Mainland GTP RoW are identified as having a moderate to high erosion potential. Providing the recommended management and mitigation measures from Section 6.4 and the ESCP (refer Appendix A) are successfully implemented during the construction of the dams, the residual impact can be limited to acceptable and manageable levels.

The dams will not be required over the long term, and will be constructed for the specific purpose of hydrotesting and decommissioned and the area rehabilitated following the completion of the hydrotest program as per the measures outlined in the LRMP (refer to Appendix G) and Chapter 15 of this EM Plan.

6.3.2 Impacts on flora and fauna

Vegetation clearing and habitat loss

The primary risk to flora and fauna is related to the clearing of vegetation. Vegetation clearing directly impacts on the vegetation that is to be cleared, and also has the potential to

result in the loss of fauna habitat through initial site preparation and dam construction-related clearing activities.

Fauna may be disturbed by the activities associated with the construction, operation, and decommissioning of the dams. Small ground mammals (eg rodents and insectivorous marsupials), reptiles and amphibians may be directly disturbed by vehicular movement and groundbreaking activities. As many species within these groups shelter within or utilise ground habitat features, there is the potential for these groups to be affected by these works. Where trees are required to be cleared, fauna utilising arboreal hollows and trees as feeding resources (e.g. possums, gliders and many species of birds and insectivorous bats), may be affected by the removal of these habitat features during construction and operation of the dams.

Control measures will be implemented as per the SMP (Appendix B), SSMP (Appendix C) and Section 6.4 of this EM Plan, to minimise potential impacts to habitat loss during construction and operation of the dams. It is therefore expected that impacts relating to habitat loss will be moderate, but manageable during construction of the dams.

Fauna injury and mortality

Potential impacts relating to fauna mortality during construction of the dams is considered unlikely due to the localised nature of construction activities for the dams.

Notwithstanding the low risk of fauna mortality specific strategies as outlined in Section 6.4 will be implemented. It is therefore considered that impacts relating to fauna mortality during construction of the dams will be low and manageable.

Dust impacts on adjacent vegetation

Deposition of dust, sand and soil as a result of dam construction activities may have potential impacts on vegetation if excessive levels are sustained over extended periods by reducing the amount of light penetration on the leaf surface, blocking and damaging stomata, and slowing rates of gas exchange and water loss. Reduction in the ability to photosynthesise due to physical effects may result in reduced growth rates of vegetation and decreases in floral vigour and overall community health.

The majority of the flora species that occur along the Mainland GTP RoW typically exhibit physiological qualities that are not sensitive to dust deposition. As such, it is unlikely that dust deposition impacts will be significant for these species. Dust deposition may impact upon less tolerant species, however these impacts will be temporary due to the short-term nature of the dam construction.

Weeds

Very few Weeds of National Significance (WONS) and species declared under the provisions of the LP Act were detected within the Mainland GTP RoW (refer Chapter 9 for further details). *Parthenium* and Giant rat's tail grass are known within the Mainland GTP RoW, and have the greatest potential to significantly impact upon grazing and ecological values. Lantana (*Lantana camara*) was also detected at various locations within the Mainland GTP RoW. These weeds are considered aggressive, and could easily be introduced to new areas through poor weed hygiene practices as a result of dam construction.

Control measures will be implemented to minimise the risk of spreading *Parthenium*, Giant rat's tail grass, and other declared weeds (WONS and LP Act declaration) during the dam construction phase (refer Section 6.4 and the PWMP (Appendix D)). It is therefore anticipated that dam construction impacts will be low and manageable.

Pests

Introduction and proliferation of pest species during dam construction and operational phases may cause environmental harm when appropriate mitigation measures are not implemented.

Anoplolepis gracilipes (Yellow crazy ants) and *Solenopsis invicta* (Fire ants) are exotic species that have the potential to seriously impact on native flora, fauna and ecological communities. They are capable of being transported from infested sites to new construction sites on equipment or within materials. Additional pests species such as Feral pigs, Feral cats, Dogs, Dingos, European rabbits and Cane toads are also known to occur with the Project area. The provision of additional watering points within the landscape may also facilitate the spread of these feral species by providing critical resources (eg breeding sites).

Control measures as outlined in the PWMP (refer Appendix D) will be implemented, (with consideration to the existing EPBC Act Threat Abatement Plans for Feral pigs, Feral cats, Red fox, European rabbit, and Cane toads) to minimise potential for pest introduction and proliferation during construction and operation of the dams. It is therefore considered that pest related impacts will be low and manageable.

6.3.3 Impact on water values

Surface water

Activities associated with the construction of dams in the vicinity of drainage lines have the potential to mobilise sediment thereby potentially increasing the sediment load of nearby watercourses. Clearing and grading works in particular have the potential to cause increased sediment movement. There is also the potential for the sediment within the cleared areas to become airborne during times of increased wind. This has the potential impact of causing a social nuisance and transferring sediment to nearby surface water bodies.

Appropriate siting consideration of the dams will minimise the potential harm to surface water values. Additionally, management measures identified in this EM Plan and the ESCP (refer Appendix A) will be implemented to minimise such adverse impacts.

Groundwater

The DERM database states that groundwater in the vicinity of the GTP is mostly utilised for irrigation and domestic purposes and in some places for stock watering. Based on the overall deep groundwater within the Project area (refer Tables 14.6 to 14.10 of Chapter 14), it is envisaged that the impact on the hydraulic characteristics of shallow groundwater will be negligible except where the dams directly intersects shallow groundwater.

To minimise any potential for groundwater contamination as a result of intersection of a shallow groundwater table, it is proposed to seal the dams to an appropriate civil engineering standard in all of the dams.

Local water supply

Usage of large volumes of water during the hydrotesting process has the potential to diminish local water supply sources.

To minimise such impacts it is proposed to maximise reuse of the hydrotest water along the length of the GTP. In addition, water will be sourced from approved water extraction sources and the Contractor will comply with all relevant authority requirements and procure all necessary permits and approvals.

6.4 Environmental protection commitments, objectives and control strategies – dams (construction and operation)

Environmental protection commitments, objectives and control strategies proposed are discussed in Table 6.1.

Table 6.1 Environmental protection commitments, objectives and control strategies – dams

Item	Detail
Environmental protection objective	<ul style="list-style-type: none"> To minimise and manage impacts to the ecological values of the project area and to rehabilitate disturbed areas to as close as practical to the pre-construction condition To minimise the potential impacts associated with topography, land, soils surface and groundwater environmental values.
Specific objectives	<ul style="list-style-type: none"> Erosion controlled and limited to that consistent with “natural processes” such that land capability is not reduced All erosion control strategies implemented and functional All topsoil stockpiled separately and no spoil piles remain on surface after restoration No unplanned or unapproved damage to flora and fauna No overall net loss of threatened species or communities To restore the dam construction areas to be compatible with the surrounding conditions and pre-construction land use No spread of weeds and compliant with the Weed Management Plan Prevention of direct or indirect release of contaminants to surface waters Minimisation of incidences of accelerated erosion as a result of construction activities Groundwater quality will not be impacted by development activities
Control strategies	<p>Siting</p> <ul style="list-style-type: none"> Consideration of potential impact on environmental values is incorporated into the site selection process for the dams. <p>Land</p> <p><i>Clearing and Grading</i></p> <ul style="list-style-type: none"> Clearing and grading will be conducted in a manner that: <ul style="list-style-type: none"> Does not place fill in areas where clearing of vegetation significantly isolates, fragments or dissects tracts of vegetation resulting in a reduction in the current level of ecosystem functioning, ecological connectivity and/or results in a increase in threatening processes Minimises disturbance to land in order to prevent land degradation Ensures that for land that is to be significantly disturbed by petroleum activities (except in areas of highly erosive soils), the top layer of the soil profile is removed; and (a) stockpiled in a manner that will preserve its biological and chemical properties, and (b) used for rehabilitation purposes Cleared vegetation or soil will not be pushed up against trunks of trees Cleared vegetation and soil will not be stored against fence lines Soil stockpiles will not be placed within the bed or banks of watercourses The stockpiles will be breached in suitable locations (coinciding with designated access roads or tracks, fence lines) to allow vehicular, stock and wildlife access. Vehicular movement over stockpiled soil will not be allowed Soil and surface stability will be maintained at all times (eg temporary erosion control berms, drains and sediment barriers will be installed as necessary and maintained until final construction clean-up is completed) Install, maintain and monitor erosion and sediment control devices (eg berms, jute matting) so that ground is stable and vegetation cover is maintained and promoted Ensure that runoff control devices (eg whoa boys) are maintained and work at all times to prevent erosion Carry out excavation works in conformity with the provisions of the construction EM Plan Maintain sediment control devices to ensure they remain effective including emptying regularly Sediment control measures will be used to preserve stockpiled soils to prevent siltation of any land surface and water or blockage of any existing drainage channels Where erosion management structures are impacted they will be reinstated as quickly as practicable or alternative structures erected to retain an adequate level of erosion control Erosion control measures put in place prior to construction will be recontoured to the

original conditions as soon as practicable following construction, in consultation with the landholder

- An inspection and maintenance program for the erosion and sediment control features will be developed
- Inspection and maintenance of erosion control devices will ensure adequate access to control devices and identification of measures required to remediate any failures

Rehabilitation

- Rehabilitated areas will be maintained to ensure:
 - Stability
 - Erosion control measures remain effective and stormwater runoff does not negatively affect waters
 - Plants show healthy growth and recruitment is occurring
- Subsoil will be respread and compacted with crown development
- Areas will be deep ripped prior to topsoil spreading in consultation with the landholder
- The area will be re-profiled to original or stable contours, re-establishing surface drainage lines and other land features
- Topsoil application will only take place after subsoil respreading and compaction and will be evenly spread and left with a slightly rough surface
- Driving vehicles on freshly topsoiled areas will be prohibited
- Subsoil displaced and not utilised in backfill, may be stockpiled in locations approved by the landholder for use during operations
- Flagging used to identify clearing boundaries and sensitive features will be removed
- Erosion and sediment control measures will be installed. Existing soil erosion measures will be reinstated to a condition at least equal to the pre-existing state
- Fertilisers and soil supplements will be used only as necessary with the agreement of landholders and authorities
- On completion of construction on land identified as GQAL, all temporary access tracks will be removed, land management and erosion control measures will be implemented and disturbed areas will be lightly ripped, topsoil replaced and surfaces returned to preconstruction land use condition

Sodic Soils

- Clearing methods, in sodic soils, will minimise ground disturbance and maintain intact root stock as far as possible
- In areas of sodic soil, vegetation will be mulched and spread to provide additional organic matter to the soil for the reinstatement process
- In areas of sodic soil, additional soil and erosion control measures will be implemented where evidence of erosion or scouring is found
- Areas of sodic soil will be clearly marked on alignment drawing sheets
- Where strongly or very strongly sodic and/or dispersive materials are identified they will not be used for rehabilitation purposes. Suspected sodic or dispersive materials exposed as a result of site earthworks will be treated as appropriate

Acid Sulfate Soils (ASS)

- ASS/PASS are not expected to be encountered on the Mainland section. Should the soils be identified at proposed dam locations then the following typical mitigation measures would be applied:
 - An ASS investigation would be undertaken for the proposed disturbance (excavation, filling) on land areas that may potentially contain ASS (including all areas <5 m AHD) according to the Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils (ASS) in Queensland 1998
 - Detailed management measures would be provided in accordance with the Queensland Acid Sulfate Soil Technical Manual, Soil Management Guidelines 2002 to the administering authority at least 20 business days prior to commencement of excavation or filling activities within areas identified as potential for containing ASS in the investigation outlined above
 - Due regard to any comments provided by the administering authority would be taken when implementing ASS management measures
 - The location of AASS or PASS would be clearly indicated on design drawings and in the field. Cross references would be made to relevant management protocols
 - Where potential or actual ASS is disturbed during excavation, the spoil would be

stockpiled within a contained area.

- If ASS material is excavated, immediate steps would be undertaken to segregate and contain the material within approved areas and dealt with according to the established ASSMP

Land Contamination

- Consultation will continue with landholders prior to construction to determine whether any potential areas of contamination are located within the proposed dam locations
- A suitably qualified person will be onsite to identify any evidence of contamination in sections of the pipeline identified in the EIS Supplement to be proximal to areas of potential concern (AOPC)
- Site-specific and contaminant-specific management measures will be developed for any areas that are not avoidable through relocation
- If suspect contamination is found during earthworks, work in that area will stop until a suitably qualified person has inspected the site, the hazard has been assessed and appropriate action has been taken
- DERM approval will be obtained if contaminated material must be removed from the work area
- All personnel will be made aware of potential contamination issues during induction training
- Within 3 months post construction, where land has been subject to contamination caused by petroleum activities, the contaminated land status must be investigated in accordance with *Environmental Protection Act 1994* requirements and the National Environment Protection (Site Assessment) Measure 1999
- Known contaminated areas will be identified on field maps, located on site, fenced and avoided

GQAL and Strategic Cropping Land

- Siting the dams to avoid unreasonable impact to identified GQAL
- Soil management procedures will be developed and implemented and include for areas of GQAL
- Soil ground truthing will be undertaken, including identification of all sensitive soil and landform areas at the proposed dam locations including GQAL will be cross referenced to known information on land units and land systems. Any variation between identified land values and DERM data sets will be identified and explained. An assessment of the potential impacts will be provided along with appropriate mitigation measures and construction methods applicable to the identified soil types or landforms including protection and restoration of GQAL that could qualify as strategic cropping land under the Government's draft discussion paper Protection of Strategic Cropping Land
- On completion of construction on land identified as GQAL all temporary access tracks will be removed, land management and erosion control measures will be implemented and disturbed areas will be lightly ripped, topsoil replaced and surfaces returned to preconstruction land use condition

Flora and Fauna

Vegetation clearing

- No clearing of protected vegetation for field development will occur until appropriate permits have been obtained
- Clearing will be limited to the minimum area practicable. The following are examples of how this can be achieved:
 - Having defined limits on the clearing plan
 - Identification of areas where clearing is restricted
 - Demarcation of "no go" areas
 - Implementing access control
- Pre-clearing surveys will be undertaken by a suitably qualified ecologist(s) to identify and map environmentally sensitive areas and key microhabitats within proposed dam locations, including wetlands, permanent pools, habitat trees, rocky outcrops and caves.
- The location of vegetation to be retained will be clearly indicated on all construction drawings
- Flagging of clearing boundaries through areas of significant vegetation will be completed
- Areas of vegetation to be cleared will be restricted to the minimum width
- For clearing of all remnant REs will be avoided where possible. However, where

unavoidable, areas to be cleared will be clearly delineated, prior to the commencement of clearing activities

- Physical barriers will be installed around significant vegetation areas in order to restrict access and avoid disturbance
- Clearing within an Endangered and/or Of Concern Regional Ecosystem (RE) and its 200 m buffer zone, clearing will be according to the following order of preference:
 - Pre-existing cleared areas or significantly disturbed areas less than 200 m from an Endangered/Of Concern RE
 - Undisturbed areas less than 200 m from an Endangered/Of Concern RE
 - Pre-existing areas of significant disturbance within an Endangered/Of Concern RE (e.g. areas where significant clearing or thinning has been undertaken within a RE, and/or areas containing high densities of weed or pest species which has inhibited re-colonisation of native regrowth)
 - Areas where clearing of an Endangered/Of Concern REs is unavoidable
- Details of any significant disturbance to land in or within 200 m of Endangered or Of Concern will be kept and submitted to the Proponent upon request
- The clearing of any threatened ecological communities will be undertaken in accordance with any approval conditions issued by the DSEWPC, DERM and/or relevant regional councils
- Clearing and disturbance in riparian areas will be minimised to that necessary to safely construct the dams and meet other environmental requirements (eg separation of stock piles, erosion control) and will be controlled by:
 - Education of all personnel on procedures for working in these environments
 - Reviewing and accepting detailed procedures to be submitted prior to commencing these activities
 - Continuous monitoring of these sensitive operations to ensure compliance with the procedures
- The relevant EO will coordinate with the spotter catchers and construction team during clearing activities
- Where habitat is to be cleared, appropriate mitigation measures will be implemented including adopting a protocol to ensure that appropriately licensed (DERM approved) and experienced spotter catchers are onsite during all clearing of identified at risk fauna areas
- Clearing will be conducted in a sequential manner and in a way that directs escaping wildlife away from the activity and into adjacent natural areas
- Minimise the clearing of mature and hollow bearing trees. Removal of nests and other breeding sites will be conducted in accordance with approval conditions under the NC Act and/or the EPBC Act
- Due to the selective nature of Gliders and their food resources, Glider feeder trees will be retained wherever possible
- Cleared native vegetation and timber will be respread over the RoW to aid regeneration and provide fauna habitat (subject to landholder agreement)
- Cleared vegetation will be stockpiled for respreading during rehabilitation
- A return of operations form will be sent to the Proponent immediately after clearing activities are completed or if the NC Act clearing permit ceases to have effect. This document will include all details of the clearing outcomes
- Where applicable, collection of local provenance seed from the listed communities will be carried out prior to the commencement of clearing activities throughout the time between contract award and commencing clearing
- In the event of a non-compliance, the Contractor will issue a “stop work” order, upon which all work will cease until the non-compliance has been rectified and measures implemented to prevent the breach re-occurring

Fauna management

- Fauna Management Procedures will be developed as part of the Construction EM Plan, and be made available to GLNG as requested and will detail all fauna mitigation measures
- A pre-construction vegetation survey will be completed in targeted areas to identify for flagging individual EVNT species and trees that contain hollows that may be avoided during construction
- The development of management strategies to minimise impact on any endangered, vulnerable or rare species
- Minimising the clearing of mature and hollow-bearing trees
- Temporary exclusion fencing where practicable to restrict fauna access to the excavation
- A copy of the fauna management procedures will be made available to the administering authority on request

Weeds

- A Pest and weed management plan will be prepared in accordance with:
 - Each of the respective Regional Council's weed and pest animal management plans
 - The *Land Protection (Pest and Stock Route Management) Act 2002*, which governs actions with respect to the control and management of declared plants and animals in the state
 - The requirements of relevant weed management officers of the Department of Employment, Economic Development and Innovations (DEEDI) (formally Primary Industries and Fisheries) and the relevant local councils
 - Biosecurity Queensland's Annual Pest Distribution Survey 2008 data and predictive pest maps available on the DEEDI website: http://www.dpi.qln.gov.au/cps/rde/dpi/hs.xsl/4790_9827_ENA_HTML.htm; and
 - Queensland Herbarium naturalised flora data
- The Contractor will prepare a Pest and Weed Management Plan to minimise the risk of weed and pest species establishing within and adjacent to the RoW. The PWMP will be in accordance with GLNG Operations PWMP and shall specifically address:
 - The prevention and management of weed disturbance to *Cycas megacarpa*
 - The prevention and management of weed disturbance to significant ecological communities
 - The prevention and management of feral fauna species on Fitzroy River Turtle habitat and mapped migratory bird roosting sites
 - The prevention and management of feral fauna species on significant ecological communities
- Control programs will be prioritised to high risk areas adjacent to land of conservation significance
- Following rehabilitation, weed survey and control will be incorporated into the monitoring plan
- Weed inspection of the RoW will be completed prior to construction and the location of declared plants and other weeds recorded
- The weed control program will consist of the following strategies:
 - Vehicle and equipment washdowns
 - Record keeping
 - Close monitoring
 - Spraying
 - Vehicle stickers
 - Training
 - Management of vehicle movements

Pests

- A Pest and Weed Management Plan (PWMP) will minimise the risk of weed and pest species establishing within and adjacent to the RoW. The PWMP shall specifically address:
 - The prevention and management of weed disturbance to *Cycas megacarpa*
 - The prevention and management of weed disturbance to significant ecological communities
 - The prevention and management of feral fauna species on Fitzroy River Turtle habitat and mapped migratory bird roosting sites
 - The prevention and management of feral fauna species on significant ecological communities
- Ensure that all food scraps and other waste material is correctly disposed of and stored in appropriate containers to prevent pest and other fauna from access

Water

- Dams will be sealed
- Water will be sourced from approved water extraction sources
- The Contractor will comply with all relevant authority requirements and procure all necessary permits and approvals
- Erosion sediment control measures will be located on the lower side of topsoil and bed and bank stockpiles and installed between the watercourse and the construction area to minimise sediment releases
- Where required, sandbags, gabion or other scour protection measures will be installed, ensuring these are placed to conform as far as possible with existing natural contours

	<ul style="list-style-type: none"> • All dewatering will be through erosion and sediment control devices • Wastewater from construction, cleaning and testing operations will be treated and managed in accordance with the relevant environmental authorities • A water supply strategy will be developed for the provision of water for the pipeline's construction. All necessary approvals will be sought from the relevant authorities <p>Operational phase</p> <ul style="list-style-type: none"> • Typical mitigation and controls for the operational phase of the Project will be detailed in the Operational Management Plan, which will be developed prior to construction
<p>Performance indicators</p>	<ul style="list-style-type: none"> • Erosion is consistent with natural processes. • Land capability is not reduced • Erosion control strategies are functional • Topsoil is stored separately and no spoil piles remain on surface after restoration • No unplanned or unapproved damage to flora and fauna • No spread of weeds and compliant with the Pest and Weed Management Plan or CEMP • No new weed infestation as a result of construction or operational activities. • Soils and vegetation stored appropriately to allow for restoration of disturbed areas to equivalent to surrounding area after construction • No direct or indirect release of contaminants to surface waters • Minimisation of incidences of accelerated erosion as a result of construction activities • Groundwater quality is not impacted by development activities

7. Land management

7.1 Chapter summary

This section describes the existing environment and potential impacts related to topography, geology, soils and agricultural land within the Mainland GTP RoW. It also discusses the potential for Acid Sulfate Soils (ASS) and contaminated land to exist.

For the purpose of describing the topography, geology, soils and agricultural land of the Mainland GTP RoW, the Project has been divided into the following six sections:

- Fairview to Top Escarpment (KP 0 to KP 28.25)
- Arcadia Valley (KP 28.25 to KP 137.75)
- Expedition range to East of Dawson Highway (KP 137.75 to KP 182.75)
- East of Dawson Highway to North of Burnett Highway (KP 182.75 to KP 313.75)
- Callide Range (KP 313.75 to KP 354.75)
- East of Callide Range to start of Marine Crossing GTP (KP 354.75 to KP 406 (Point A of Marine Crossing GTP))

7.1.1 Summary of existing land values:

A summary of the existing land values are provided below.

- Geology and geomorphological processes of the Mainland GTP RoW have given rise to a variety of landform, soil and vegetation types. Therefore, the study area is characterised by localised landform and vegetation variability
- Geological regimes are highly variable however sedimentary rocks are dominant
- The Mainland GTP RoW alignment crosses several ranges including the Expedition, Dawson, Cooper, Callide, Calliope, Mt. Alma and Mt. Larcom Ranges. At these locations environmental constraints will be high as rock is likely to be close to surface and gradients may be steep
- The variable topography and undulating relief has resulted in small pockets of variable soil types occurring across the Mainland GTP RoW. The soils of the Mainland GTP RoW can be separated into nine broad groups (Figure 7.3)
- Some soils (generally class 6-8) are classed as Good Quality Agricultural Land (GQAL). Small areas of GQAL are located in the CICSDA and GSDA corridors, with the main areas located near Scrubby Mountain, Mount Larcom, the crossing of the Calliope River and along the Dawson Highway through the Callide Ranges
- The majority of the soils along the alignment are considered to have moderate to high erosion potential
- Saline soils occur in terrain units associated with the Quaternary estuarine deposits and in the Silurian-Devonian extrusive and volcanoclastic geological regimes (Figure 7.1). Moderately to highly saline soils most likely occur in the Quaternary alluvial deposits, mainly in terrain unit Qa1/6-8 and in the older alluvial deposits in terrain units Czs1/6-8 and Czs2/6-8. It is highly likely that subsoils with high salinity potential are present between KP 175 to KP 300
- Sodic soils are indicated along the majority of the Mainland GTP RoW
- Reactive soils occur in terrain units mainly with Soil Group 8 and in places in Soil Group 9. Erodible swelling clay soils (Vertosols) with highly sodic subsoils are present at various locations west of the Calliope Range
- The desktop study undertaken during the EIS indicates that ASS do not exist within the Mainland GTP RoW
- A preliminary site contamination investigation undertaken as part of the EIS identified nine Areas Of Potential Concern in proximity to the Mainland GTP RoW (Figure 7.7)



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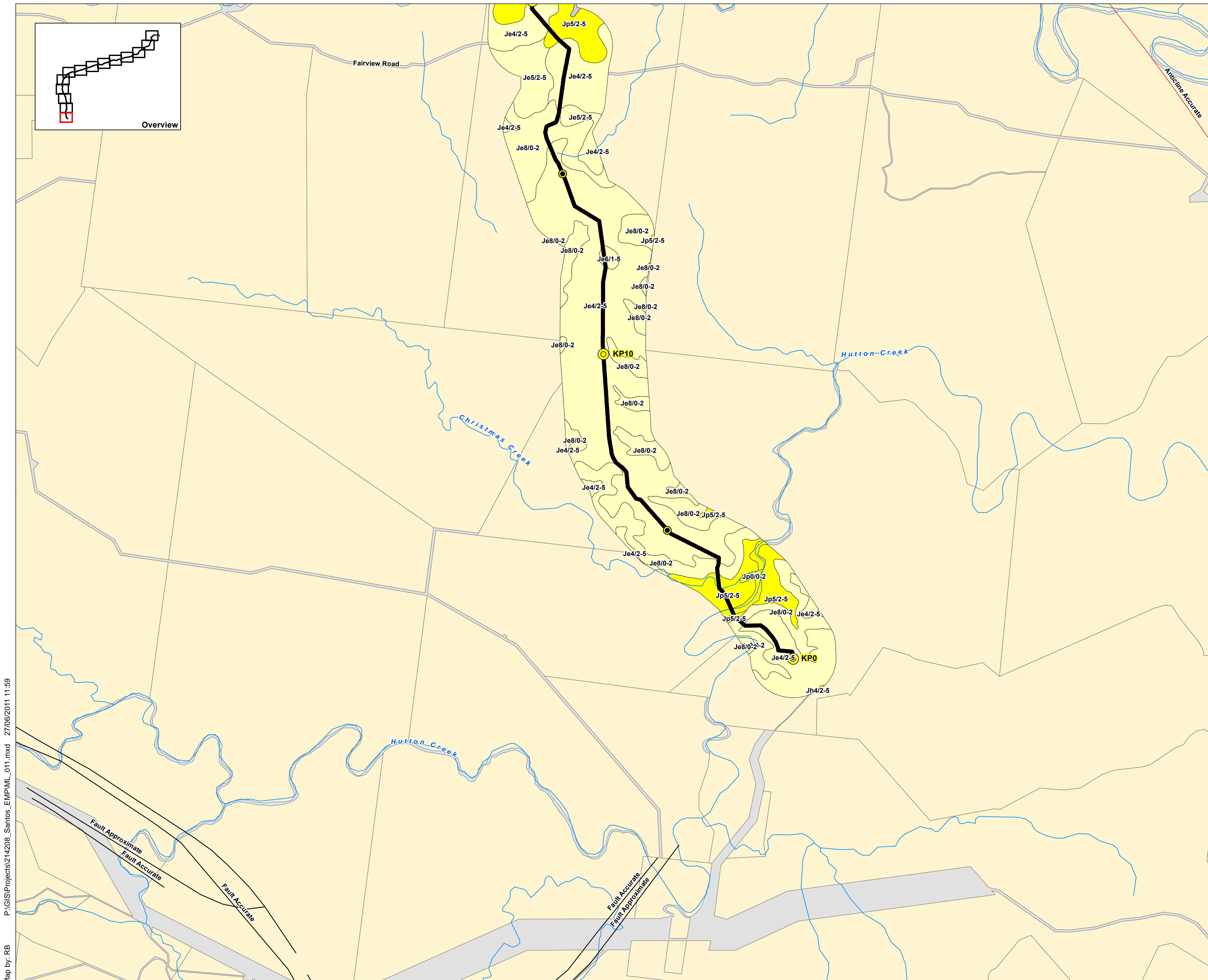
Note: All figures should be reviewed in conjunction with Table 7.1 "Generic Key to the Identification of Terrain Units", URS 2009.

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Geological Regime Figure 7.1 (Page 1 of 14)

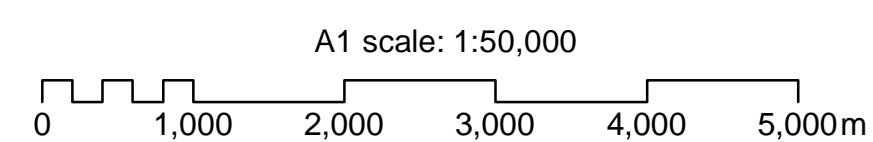
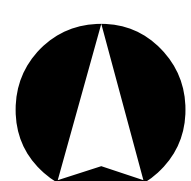
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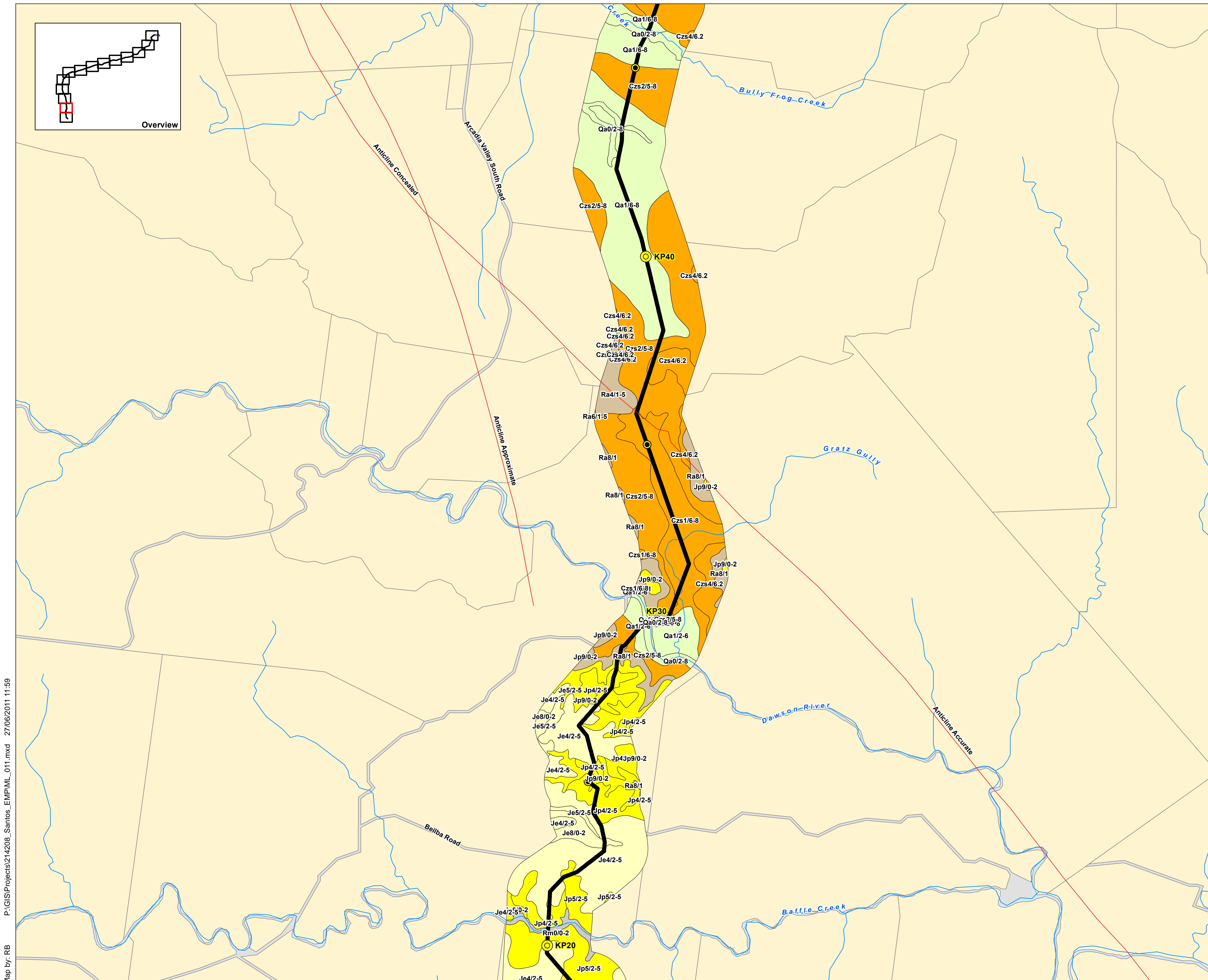
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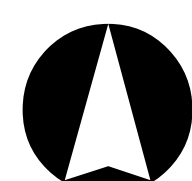
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A1 scale: 1:50,000

0 1,000 2,000 3,000 4,000 5,000m

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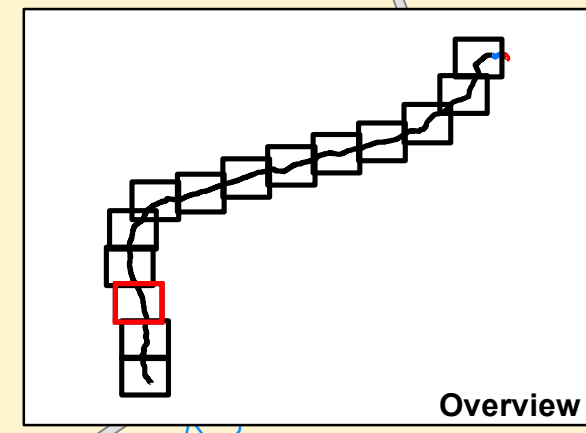
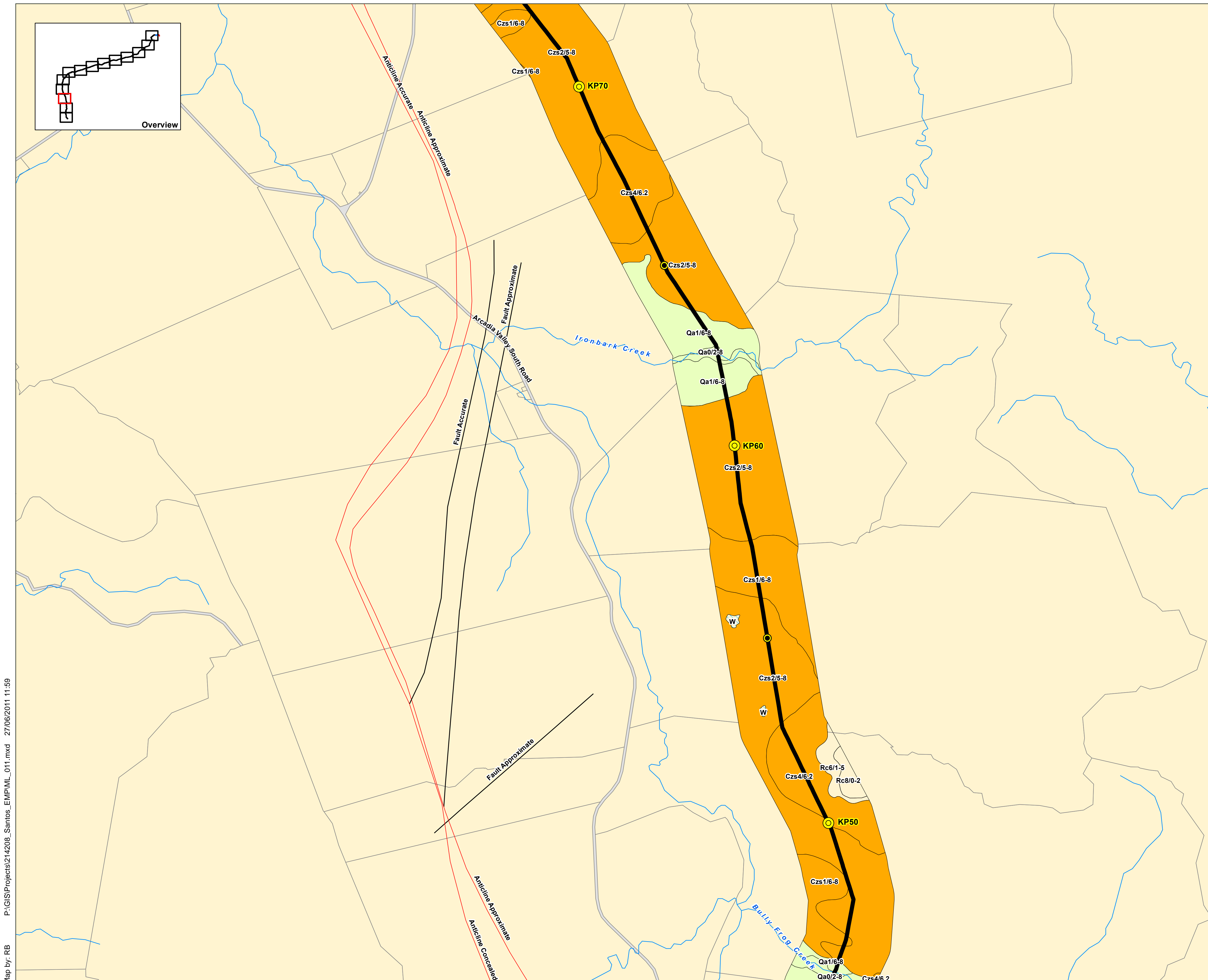
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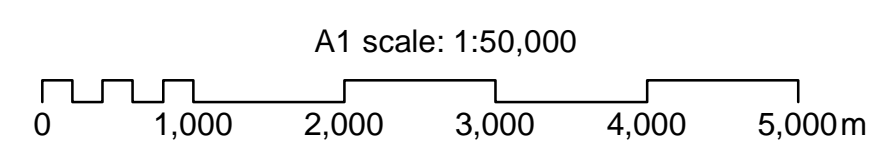
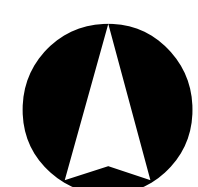
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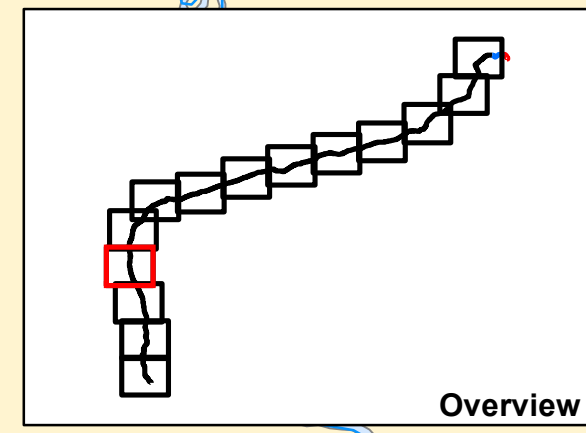
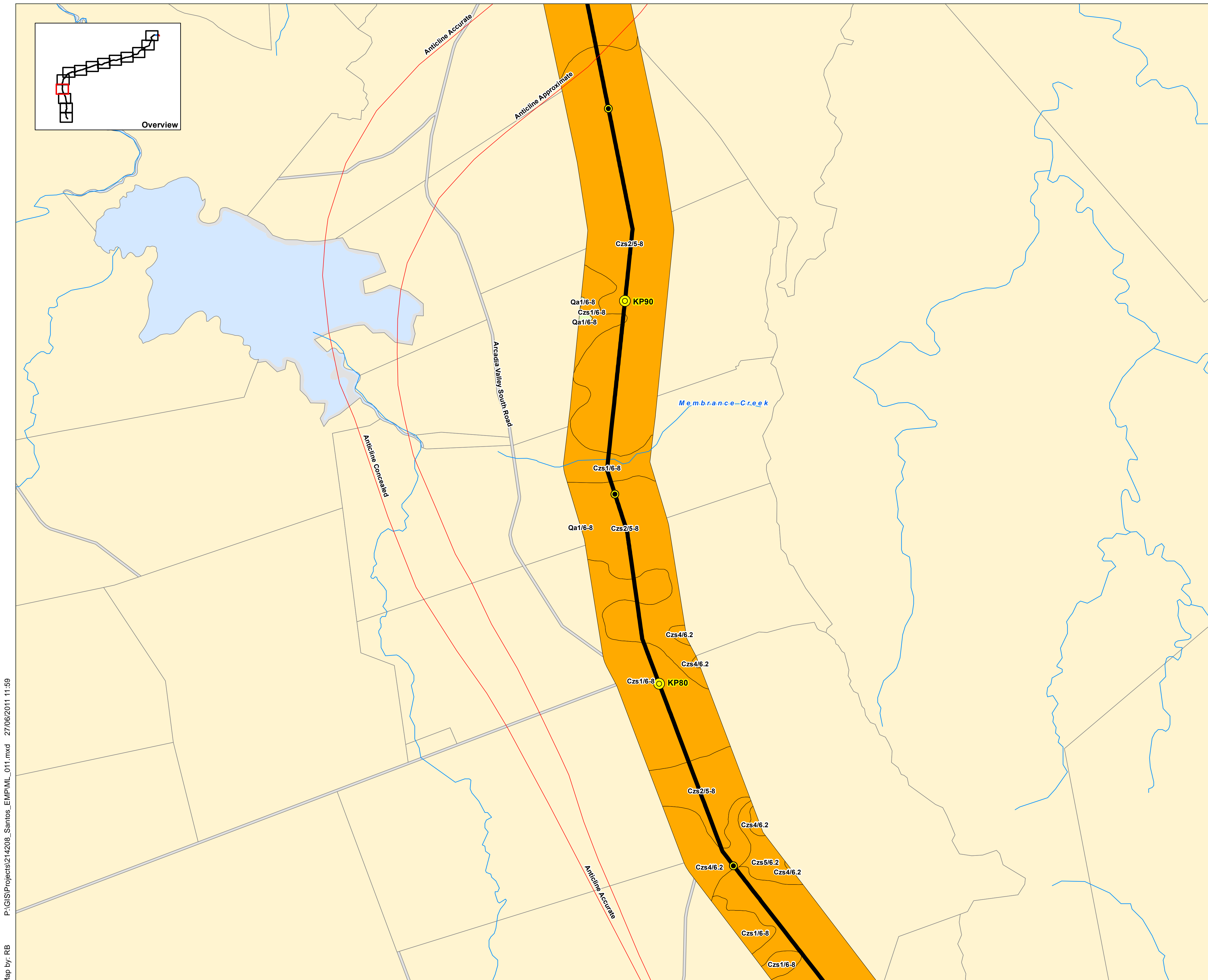
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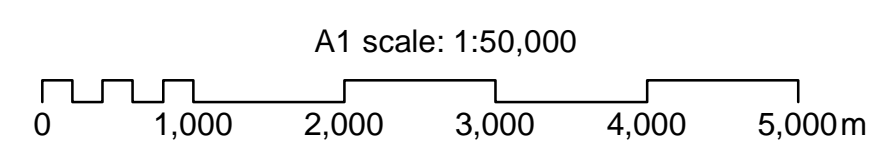
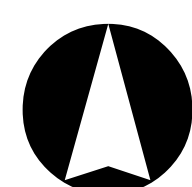
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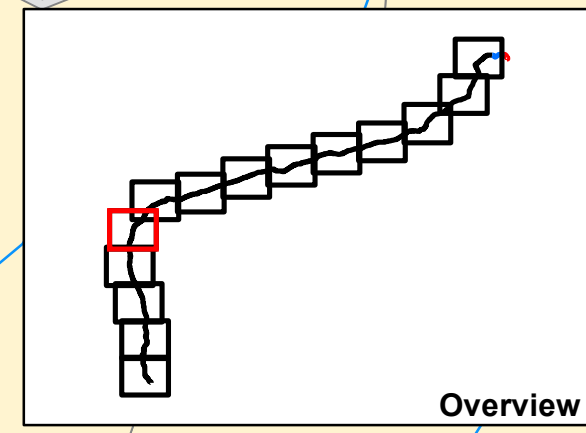
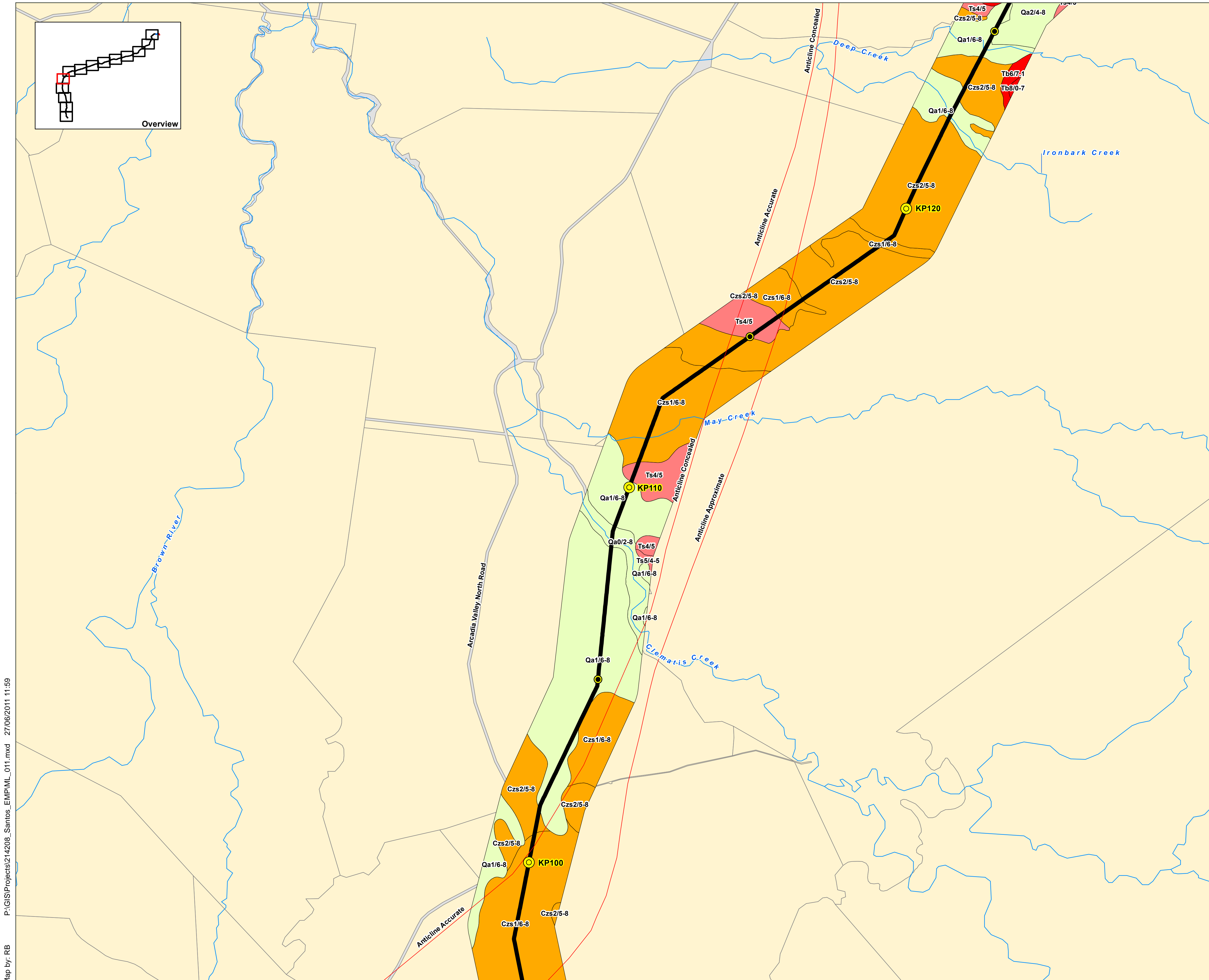
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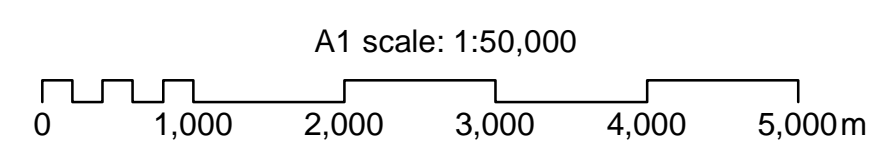
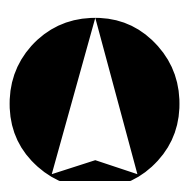
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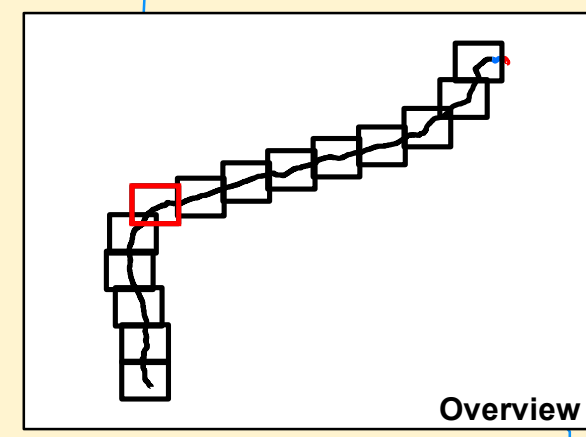
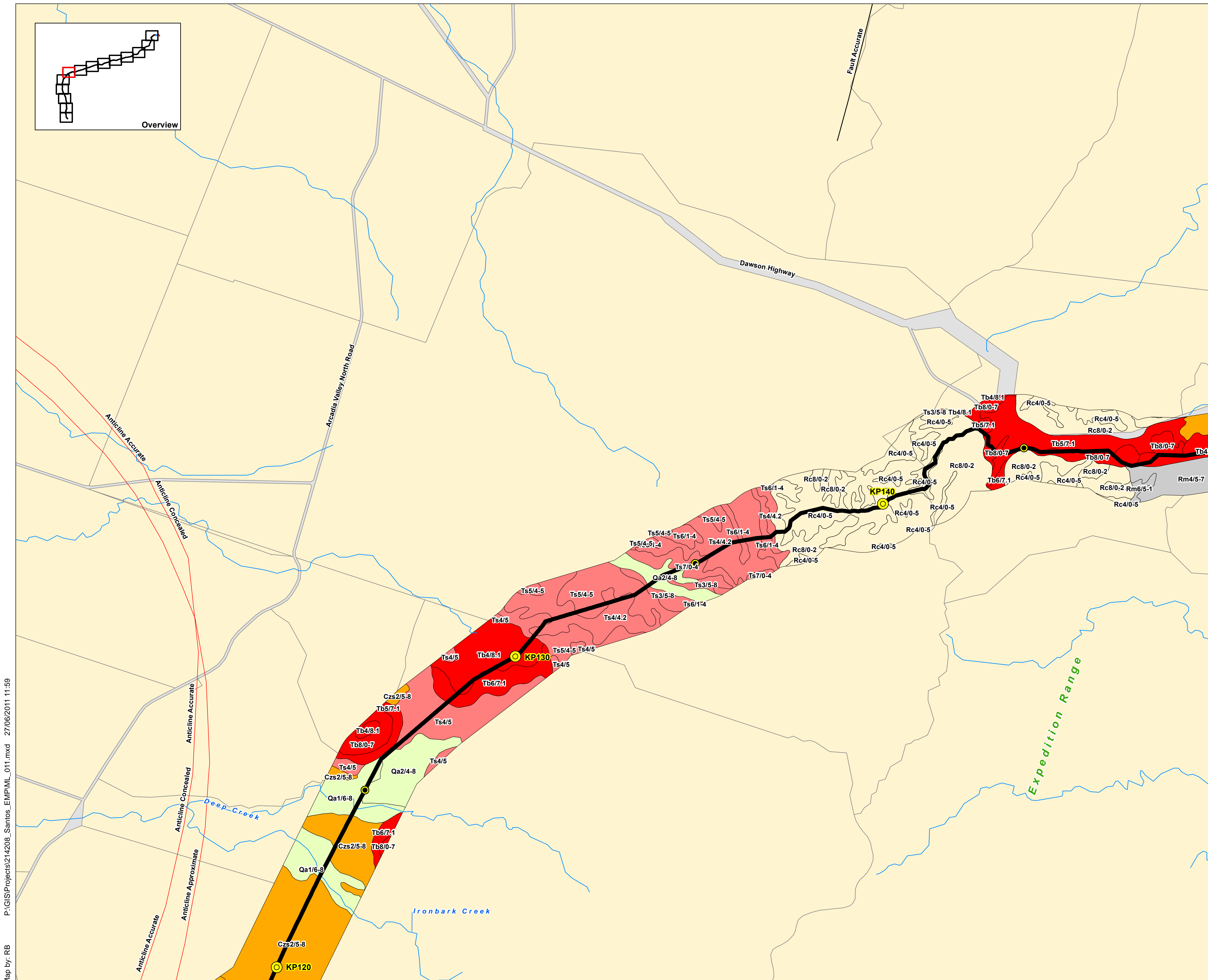
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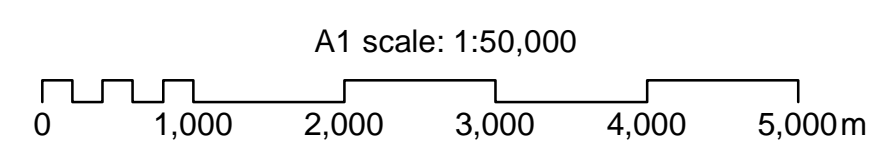
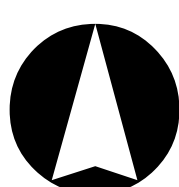
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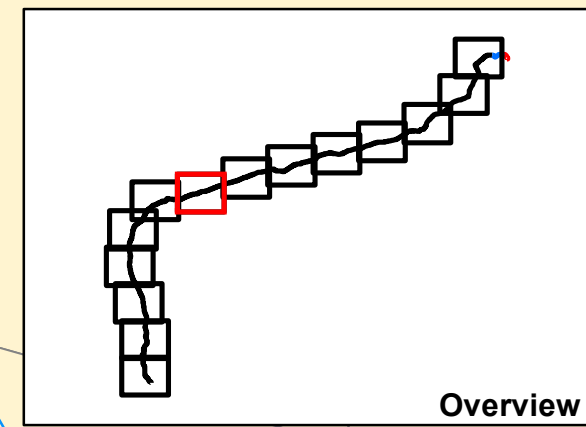
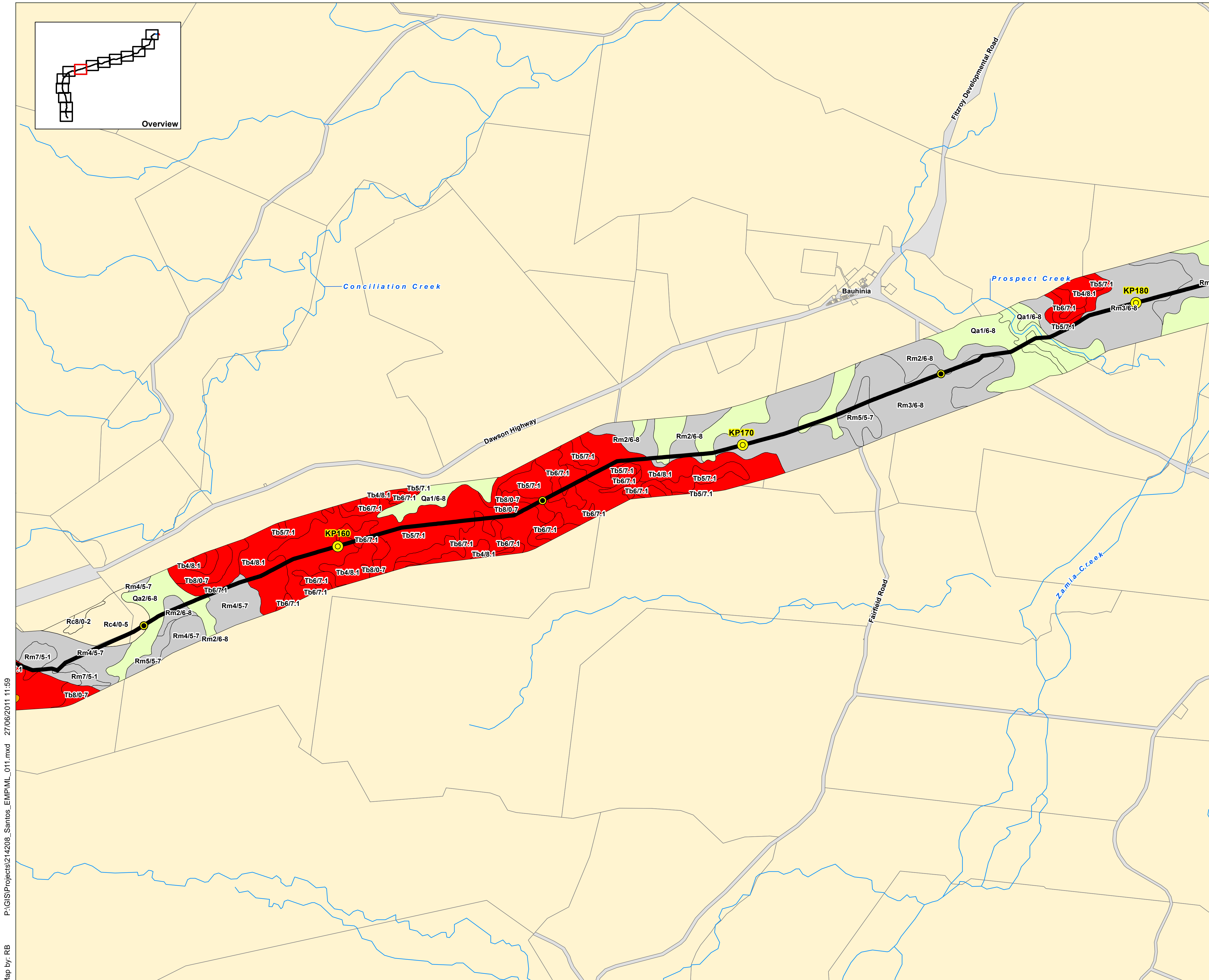
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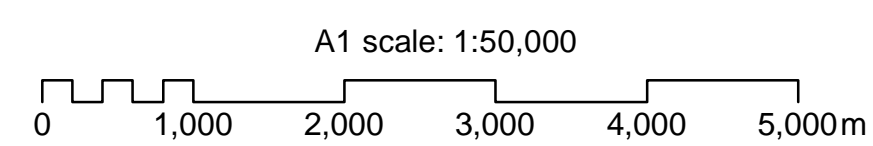
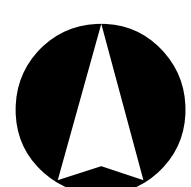
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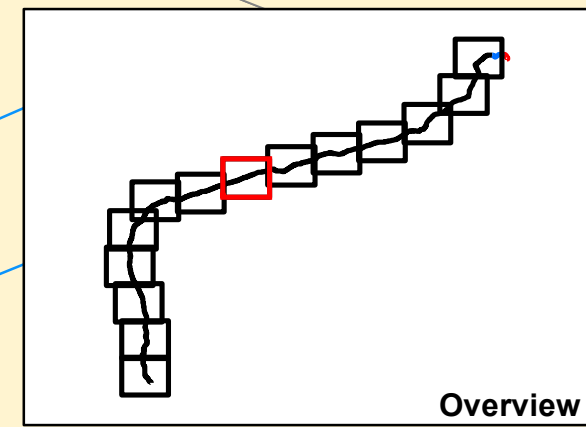
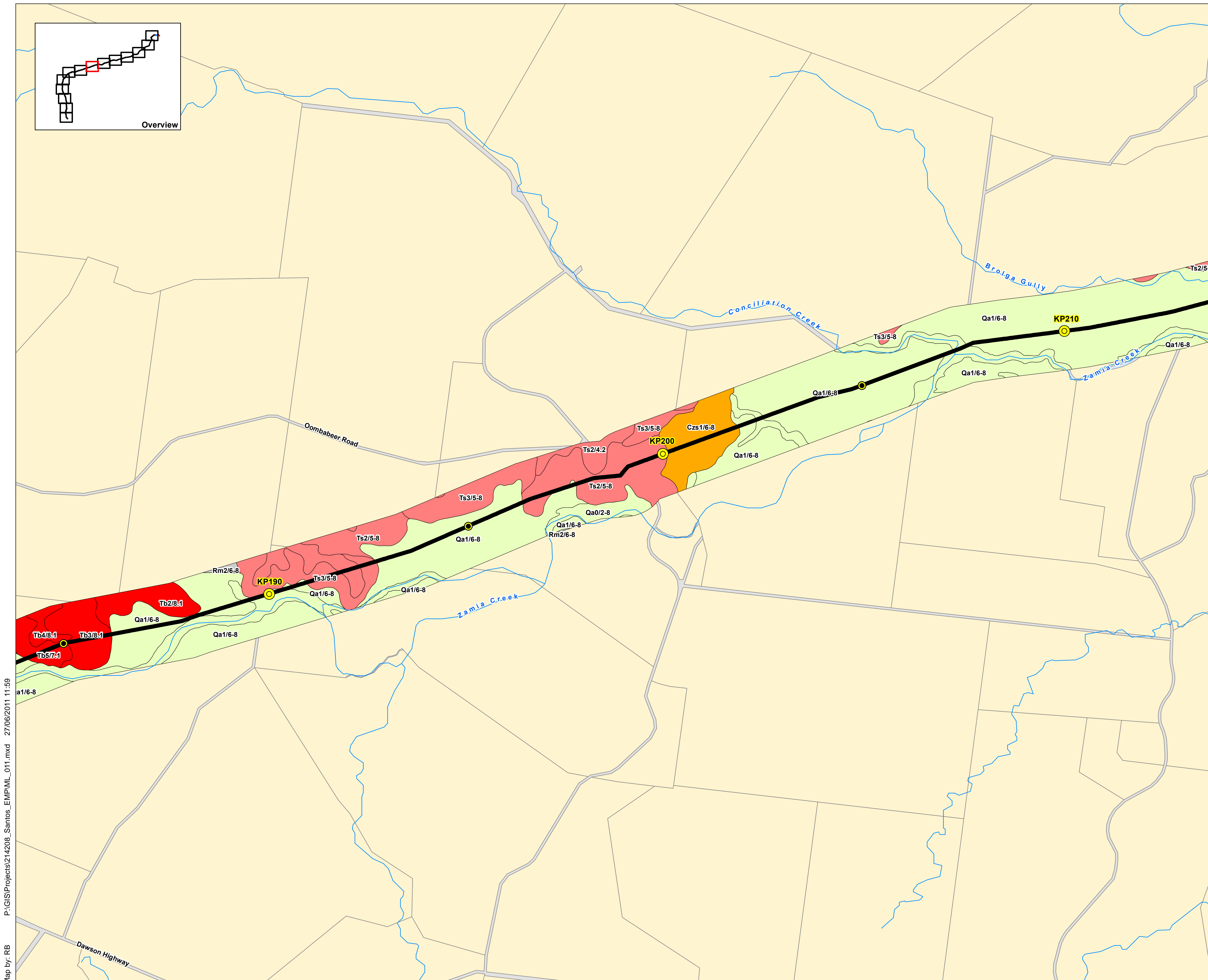
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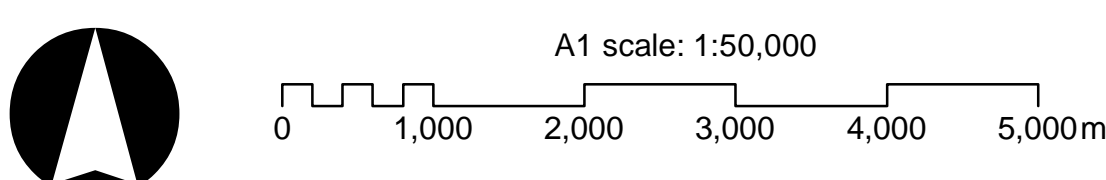
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Mainland GTP EM Plan

- Gas Transmission Pipeline (GTP)
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- Kilometre Post Distance Marker
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 - 5km

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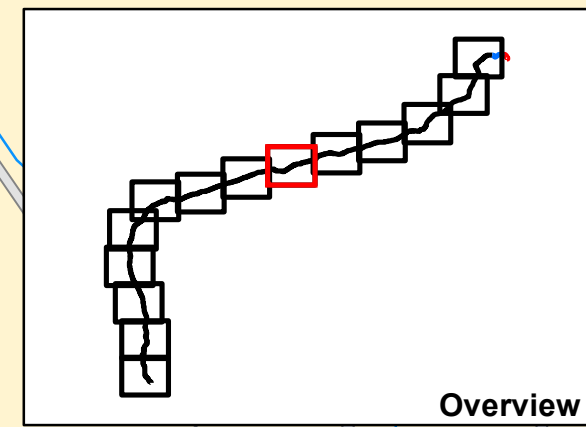
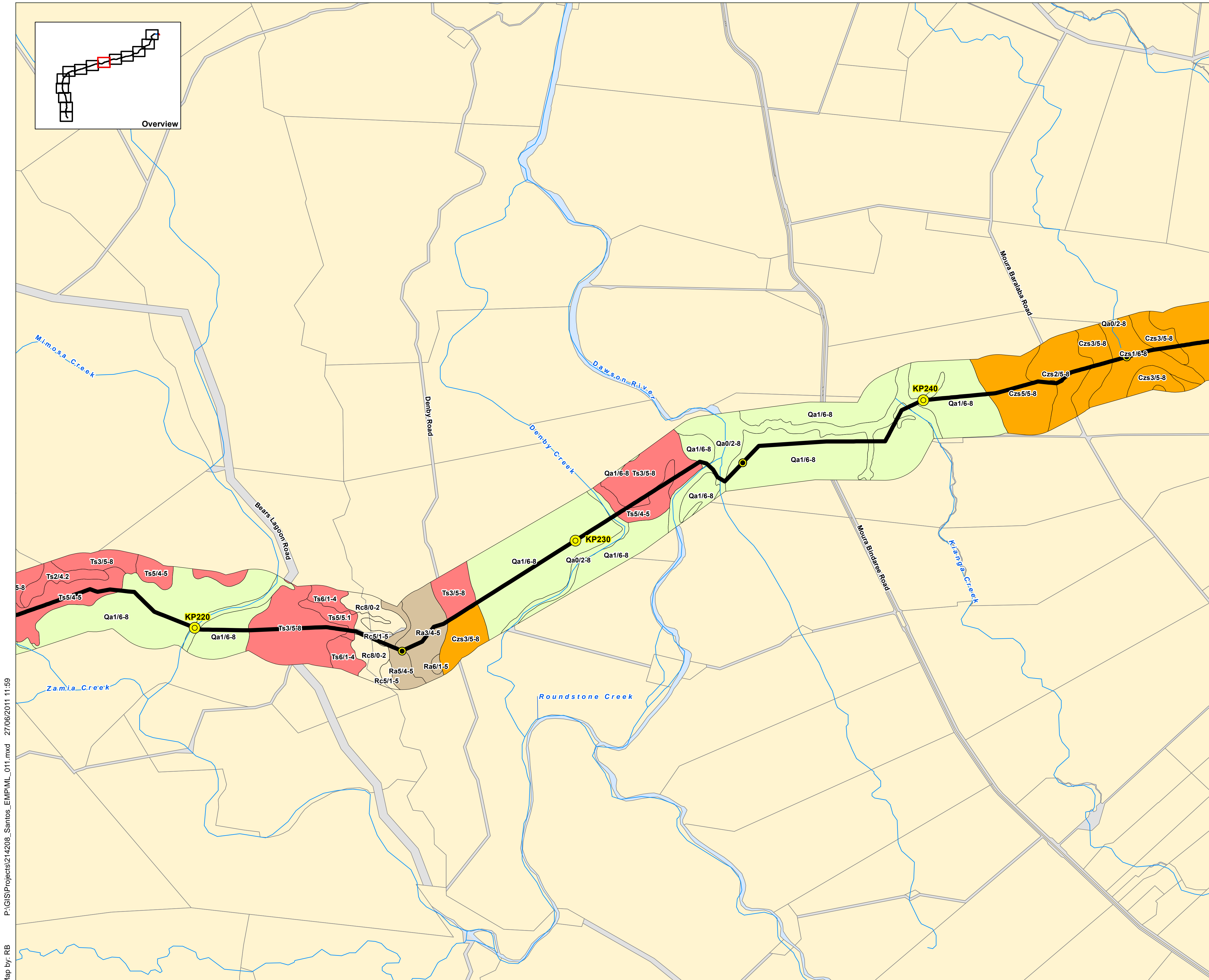
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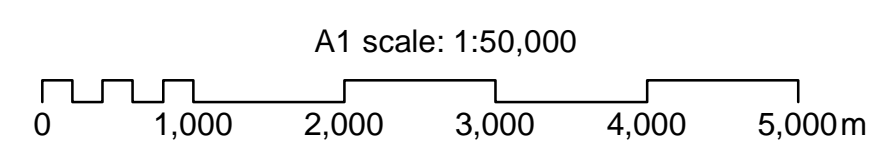
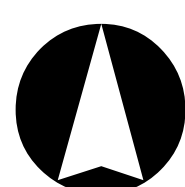
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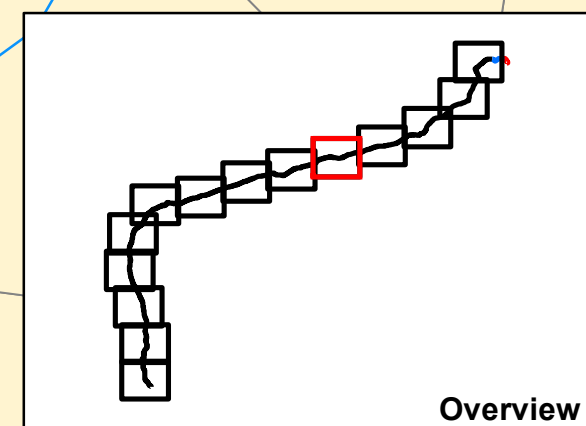
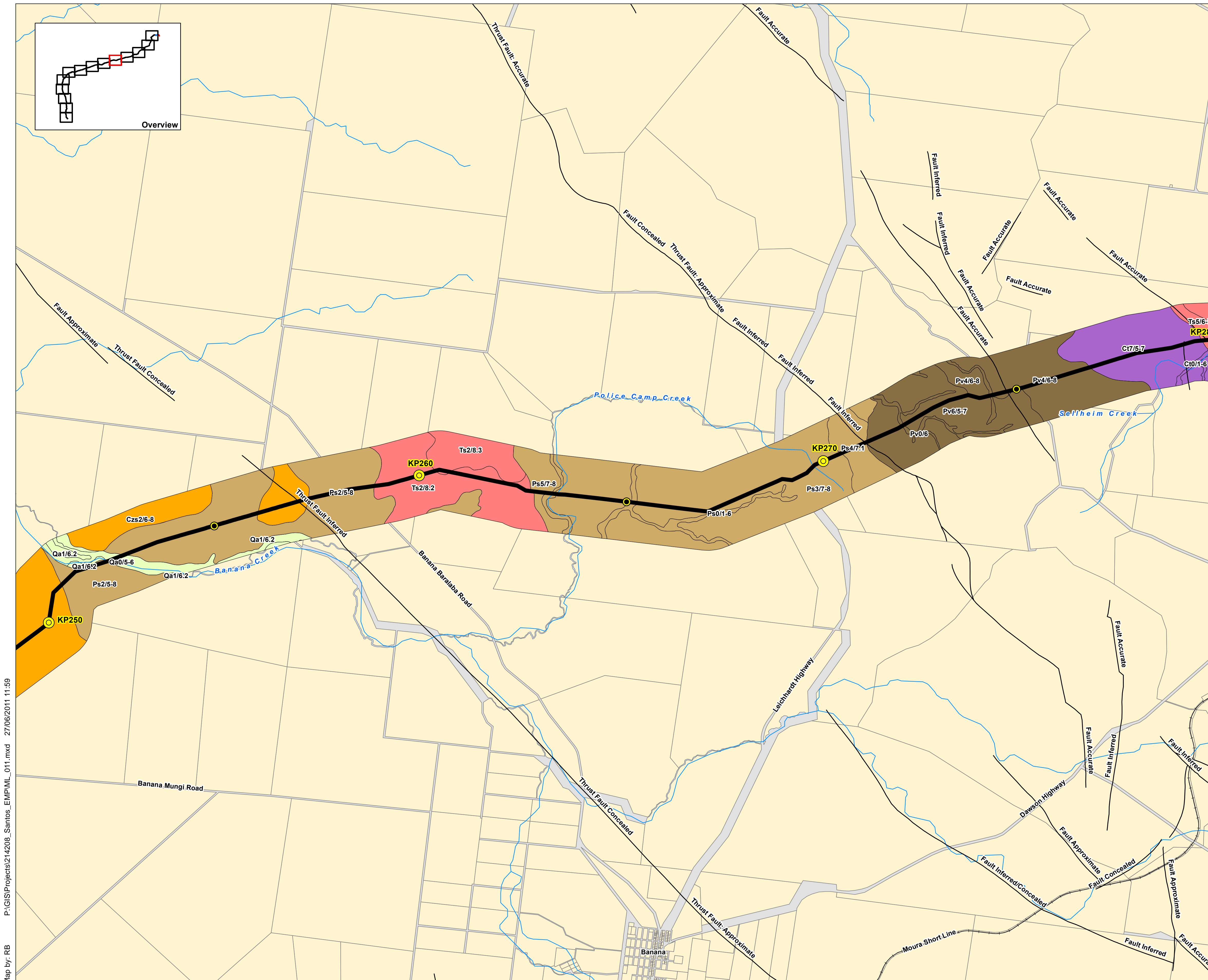
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Geological Regime Figure 7.1 (Page 10 of 14)

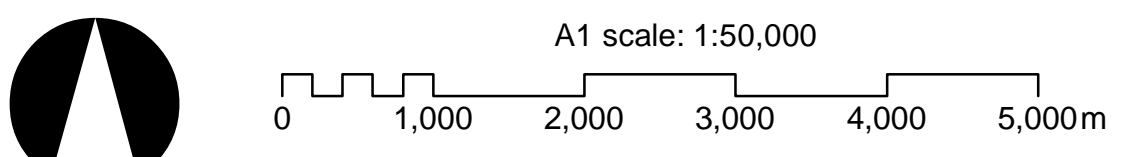
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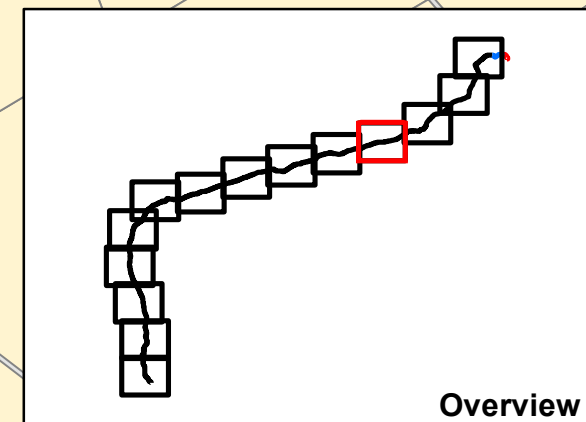
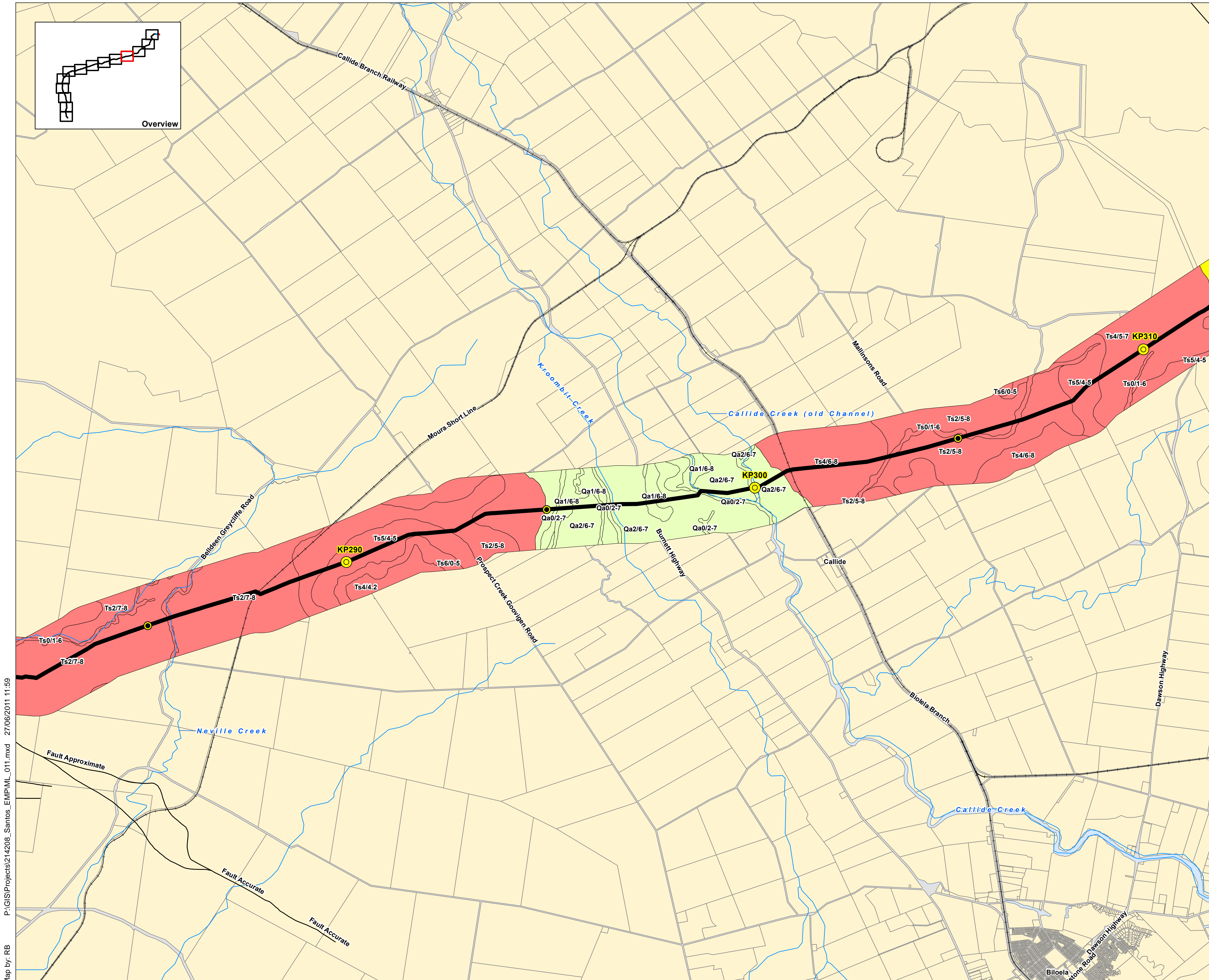
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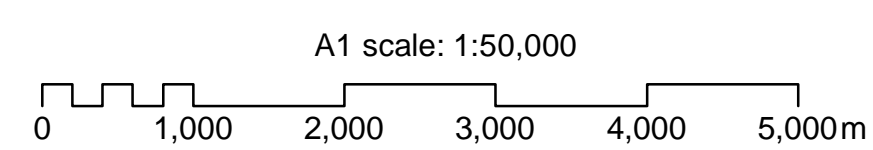
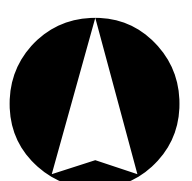
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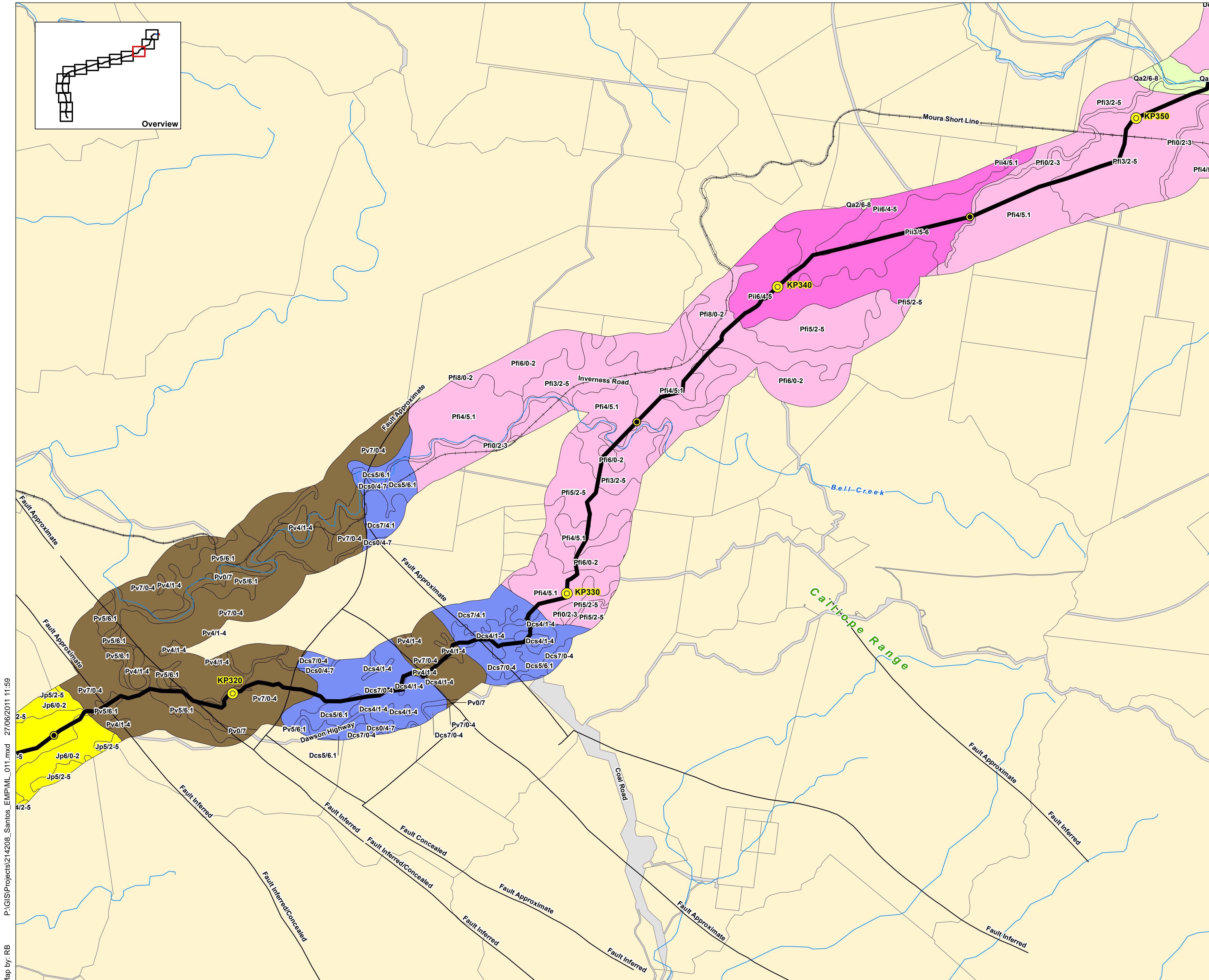
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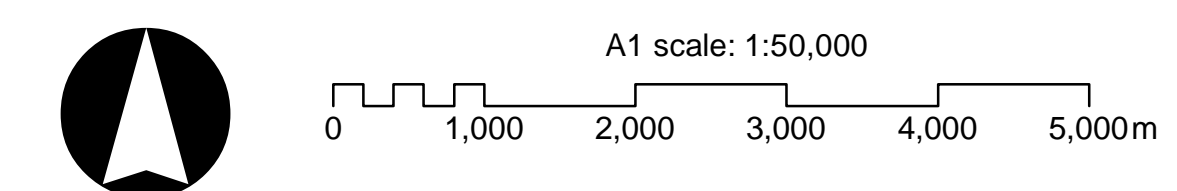
Geological Regime Figure 7.1 (Page 12 of 14)

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Mainland GTP EM Plan

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Kilometre Post Distance Marker

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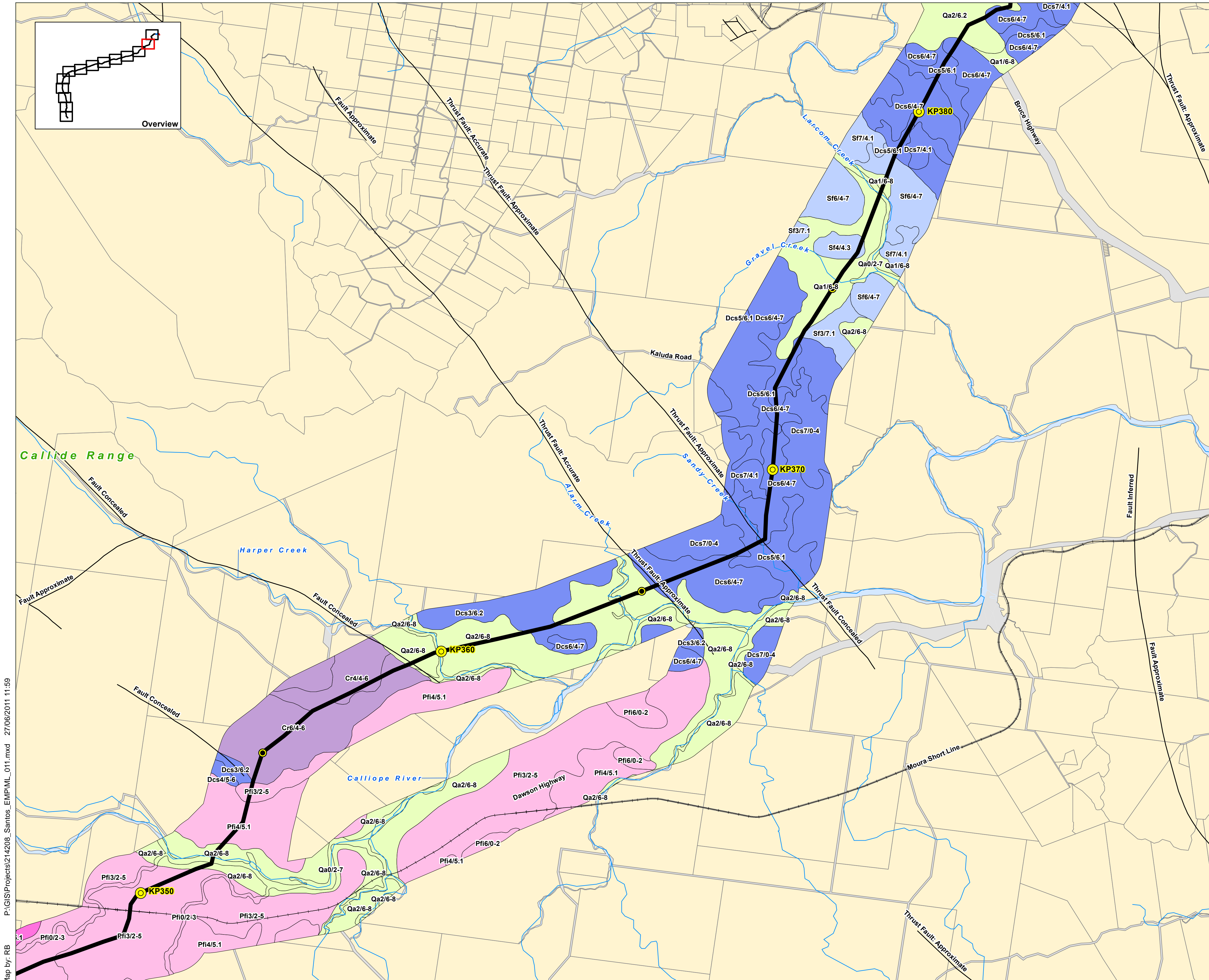
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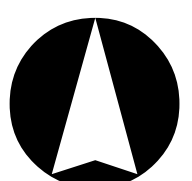
Geological Regime Figure 7.1 (Page 13 of 14)

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A1 scale: 1:50,000
0 1,000 2,000 3,000 4,000 5,000m

GLNG No: 3381-40-0405
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Mainland GTP EM Plan

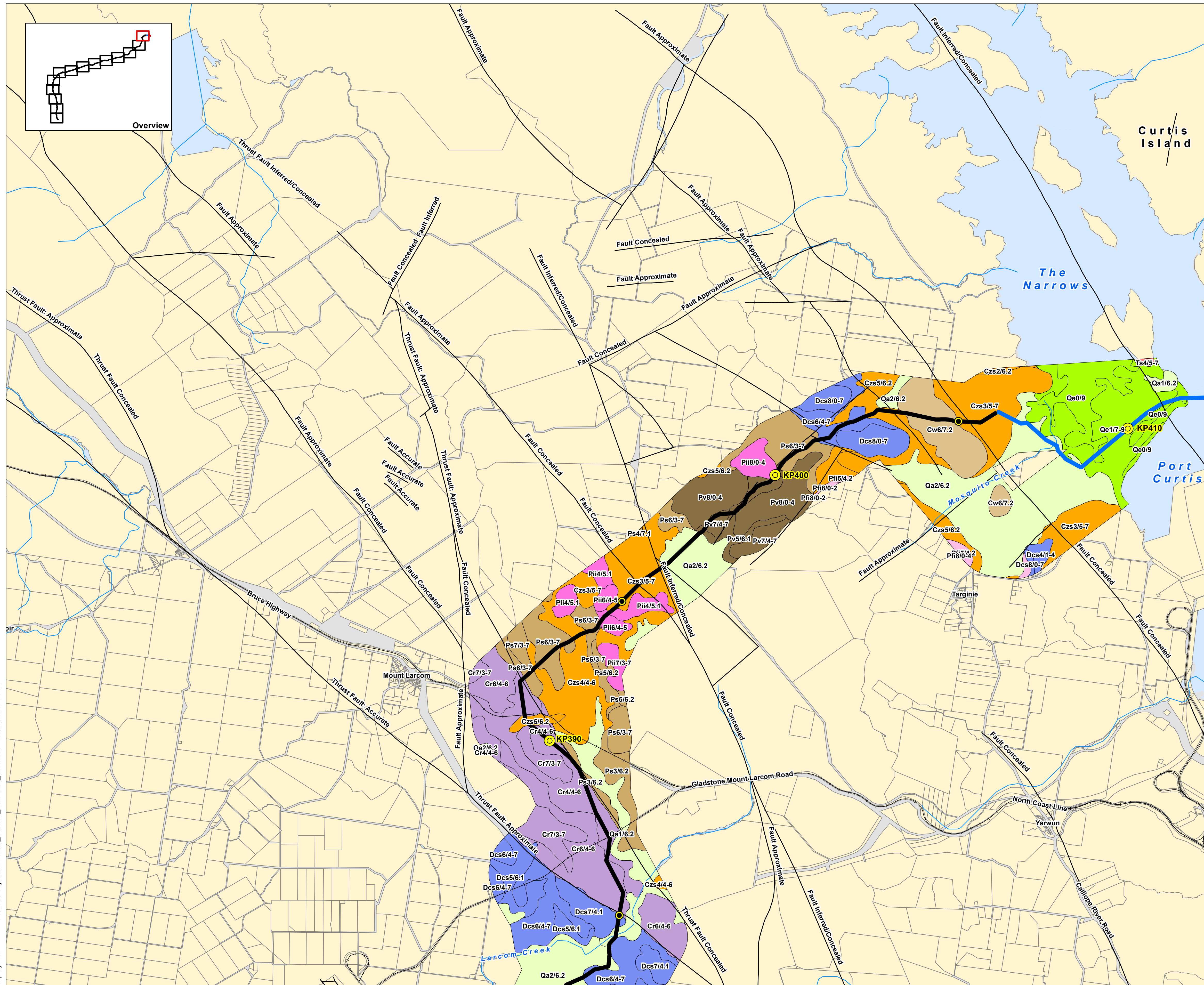
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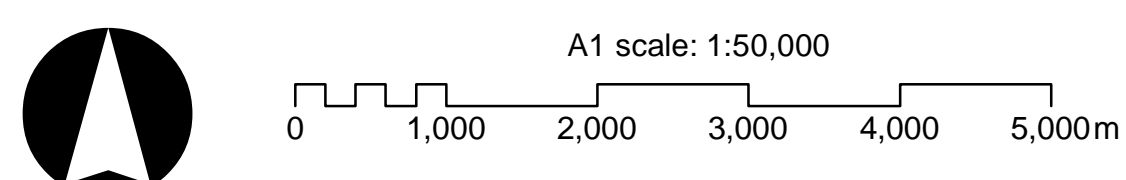
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Geological Regime
 Figure 7.1 (Page 14 of 14)



7.1.2 Summary of potential impacts

Construction

The construction of the Mainland GTP is not expected to have significant impacts on geology, however, it will involve the extraction of rock during trenching in areas where rock is close to the surface (such as the Expedition Range and Callide Range).

Potential impacts to topography include changes to gradients as a result of excavation and levelling of ground to support construction. Any impacts to topography are expected to be localised and can be limited to acceptable and manageable levels.

Without the appropriate mitigation measures, the construction of the Mainland GTP may result in a range of soil related impacts including accelerated erosion, generation of sediment, soil inversion and soil compaction. Short term impacts to GQAL and strategic cropping land may occur during construction. Of these impacts, soil erosion and sediment presents a slightly higher risk as the soils within the Mainland GTP RoW are identified as having a moderate to high erosion potential. Providing the recommended management and mitigation measure from Section 7.3 and the Erosion and Sediment Control Plan (ESCP) (refer Appendix A) are successfully implemented, the residual impact can be limited to acceptable and manageable levels.

Other identified impacts to soils including soil inversion, soil compaction, salinity, differential settlement and impacts to GQAL and strategic cropping land can also be limited to tolerable levels providing the management and mitigation measures as detailed in Section 7.6 and the LRMP (refer to Appendix G) are successfully implemented.

Operation

Regular inspections will be carried out along the Mainland GTP RoW by vehicle and foot patrols to check on the condition and identify any activities that may have the potential to impact on the integrity of the pipeline. The soil related impacts as outlined and described above will also apply to a lesser extent resulting from the operation of the Mainland GTP. Operational and maintenance activities are expected to be acceptable and manageable due to the low number of vehicles movements, infrequent maintenance activities and that these activities will be undertaken in accordance with the ESCP and OMP. The OMP will be developed and implemented prior to the completion of construction activities.

7.1.3 Summary of proposed mitigation measures for land management

Table 7.1 Soil management

Item	Detail
Environmental Protection Objective	To minimise and manage adverse impacts to soils by: <ul style="list-style-type: none"> • Limiting the occurrence and extent of trench subsidence and soil erosion • Preventing soil inversion • Developing a stable, vegetated RoW post-construction
Specific Objectives	<ul style="list-style-type: none"> • Erosion controlled and limited to that consistent with “natural processes” such that pipeline cover is maintained and land capability is not reduced • All erosion control strategies implemented and functional • All topsoil stockpiled separately and no spoil piles remain on surface after restoration • All access restricted to designated areas
Control Strategies	Refer to Table 7.4 for land management control strategies to be implemented during pre-construction, construction and operation of the Mainland GTP

Item	Detail
Performance Indicators	<ul style="list-style-type: none"> • Erosion is controlled to a degree that is consistent with “natural processes”. • Land capability is not being reduced • Erosion control strategies are functional • Topsoil is stored separately and no spoil piles remain on surface after restoration

7.2 Introduction

This Chapter describes the existing environment and the potential impacts related to topography, geology, soils and agricultural land within the Mainland GTP RoW. The assessment has been based on a review of available information. This chapter addresses the following:

- The topography of the Project area showing the significant features of the landscape (Section 7.3.2)
- The physical and chemical properties of the soils, identifying any influences on land contamination (Section 7.3.3), erosion potential (Section 7.3.7), stormwater runoff quality, rehabilitation and agricultural productivity of the land (Section 7.3.5)
- The geology of the Project area with particular reference to the physical and chemical properties of surface and sub-surface materials and geological structures within the proposed areas of disturbance (Section 7.3.1)
- The depth and quality of soil that is appropriate for use in accordance with the standards outlined in the *Planning Guidelines: The Identification of Good Quality Agricultural Land* (Department of Primary Industries (DPI) and the Department of Housing Local Government and Planning 1993), which supports the *State Planning Policy 1/92: Development and the Conservation of Agricultural Land and Identification of Good Quality Agricultural Land (GQAL)* within and adjacent to the disturbance zone of the Project (Section 7.3.5)
- Land contamination from existing and historical use, based on land use history and the nature and quantity of any contaminants (Section 7.3.11)
- Preventative strategies and mitigation measures relevant to topography, geology, soils and agricultural land issues

In regards to other land related issues that could be potentially affected by the Project; land tenure, land use, landscape and visual amenity are addressed in Chapter 8 with flora, fauna and bioregions addressed in Chapter 9.

7.3 Existing soil, land and geological environment

The terrain within the Mainland GTP RoW was assessed to identify geological regimes, landform types and associated soils. This information was compiled using the background data sources listed below which have provided the basis for identifying Terrain Units that occur within the Mainland GTP RoW. Where this information is illustrated in Figures, it is done so in a 2 km corridor along the Mainland GTP RoW. Background data sources used include:

- Colour aerial photography – Colour 06.ECW (SPOT) imagery provided by Santos Ltd. for the Mainland sectors of the GTP
- Route corridor topographic data with 5 m Light Detecting and Ranging (LIDAR) contours provided by Santos Ltd. covering the majority of the Mainland GTP RoW; with Geoscience Australia (100 k) 20 m Contours, supplemented by reference to Google Earth 3D imagery, in the southern sector of the corridor and in various route alternative corridor sectors considered

- Geological mapping derived from Regional Geological Map Sheets of the Surat Basin and the Bowen Basin, and the Gladstone 1:100,000 Series Geological Mapping, included in the Geoscience Data Set compiled by the Geological Survey of Queensland (July 2004)
- Land resources digital data sets including Commonwealth Scientific and Industrial Research Organisation (CSIRO) Land Research Series No. 19 (1967) – Lands of the Isaac-Comet Area Queensland; Land Research Series No. 21 (1968) – Lands of the Dawson Fitzroy Area – Queensland; Land Research Series No. 34 (1974) – Lands of the Balonne-Maranoa Area Queensland
- Land Resources and Evaluation of the Capricornia Coastal Lands (CCL) – Sheet 3 Calliope area, NRW Data (1995)
- Queensland Department of Natural Resources and Water (NRW – 2004) regional compilation of and mapping (1:250,000) Central West Region - Good Quality Agricultural Lands (GQAL)
- Denison Trough Gas Project – Gladstone Option. Results of Terrain Analysis and Field Investigations, prepared by Terrain Analysis QLD Pty Ltd on behalf of CSR Oil and Gas Division (1984)

A Terrain Unit comprises of a single or recurring area of land that is considered to have a predictable combination of physical attributes in terms of bedrock, surface slope and form, and soil/substrate conditions.

During the soil assessment for this EM Plan, further information obtained from field geotechnical investigations undertaken by Coffey Geotechnics (2008) were used to ‘ground truth’ the Terrain Units. Photographs of these mainland testpit (MLTP) locations have been included to support the soil descriptions in section 7.3.3 where possible. This information has been incorporated below to assess the soil, land and geological environment of the Mainland GTP RoW.

7.3.1 Geology

Geological descriptions for each of the 6 identified sections along the Mainland GTP RoW are provided below. Geology for each section is illustrated in Figure 7.1 (Page 1 of 14 to Page 14 of 14) Geological Regime.

Section 1: Fairview to Top Escarpment (KP 0 to KP 28.25)

The geology of Section 1: Fairview to Top Escarpment is presented in Figure 7.1 (Page 1 of 14 to Page 2 of 14).

The geology for this section is reported on the ‘Taroom’ 1:250,000 scale geological sheet. The geology is indicated to predominantly consist of Lower Jurassic age deposits of the Boxvale Sandstone Member comprising quartzose sandstone, minor siltstone and shale, and the Evergreen Formation consisting of labile (easily decomposable) and sublabile sandstone, mudstone, occasional shale and coal. The Lower Jurassic age Westgrove Ironstone member composed of pelletal or oolitic chamositic (iron alumina silicate) ironstone occurs locally. Middle Triassic age Clematis Sandstone consisting of sublabile sandstone, siltstone, conglomerate and mudstone, and the Lower Jurassic age Precipice Sandstone composed of sandstone and sublabile lithic sandstone and siltstone occur at the northern end of the section. Also, a cover of alluvium is mapped as associated with Hutton and Baffle Creeks.

Section 2: Arcadia Valley (KP 28.25 to KP 137.75)

The geology of Section 2: Arcadia Valley is presented in Figure 7.1 (Page 2 of 14 to Page 6 of 14).

The geology for this section is reported on the 'Taroom' and 'Baralaba' 1:250,000 scale geological sheets. These maps indicate the geology to predominately consist of Quaternary age alluvium comprising of clay, sand and gravel soil deposits overlying Lower Triassic age Rewan Formation consisting of (brown) mudstone, (green) lithic sandstone and occasional conglomerate. Tertiary age sandstone, siltstone, claystone and conglomerate occur at the northern end of the section, with small local outcrops of Tertiary basalt. The Triassic age Clematis Sandstone and Precipice Sandstone units occur at the southern end of the section.

Section 3: Expedition Range to East of Dawson Highway (KP 137.75 to KP 182.75)

The geology of Section 3: Expedition Range to East of Dawson Highway is presented in Figure 7.1 (Page 6 of 14 to Page 8 of 14).

Reference to the 'Baralaba' 1:250,000 scale geological sheet indicates the geology to predominately consist of Triassic age Clematis Formation here comprising medium grained cross bedded quartz sandstone and micaceous siltstone. East of the Expedition Range the surface geology is predominately Triassic age Moolayember Formation comprising sandstone, (grey) shale and conglomerate, overlain in areas by Tertiary basalt flows and narrow fingers of Quaternary alluvium associated with the recent surface drainage pattern.

Section 4: East of Dawson Highway to North of Burnett Highway (KP 182.75 to KP 313.75)

The geology of Section 4: East of Dawson Highway to North of Burnette Highway is presented in Figure 7.1 (Page 9 of 14 to Page 11 of 14).

The reported geology for this section is included on the 'Baralaba' and 'Monto' 1:250,000 scale geological sheets. These maps indicate the geology west of the Cooper Range to predominantly consist of Quaternary alluvium consisting of clay, sand and gravel, with local occurrences of partly laterised Tertiary age deposits consisting of sandstone, siltstone, claystone and conglomerate. Triassic age Rewan and Clematis Formations occur over a relatively short lateral distance at Dawson Range.

At Cooper Range the geology is shown as Late Permian age siltstone, mudstone, sandstone, conglomerate and intermediate volcanics. Early Permian age Camboon Andesite and the Carboniferous age Torsedale Beds comprising acidic and intermediate lava, tuff, and coarse to fine grained sedimentary rock are mapped. Faulting is reported as the contact between the latter two formations. Northeast of the Cooper Range, the surface geology moves to Tertiary undifferentiated shale, sandstone, brown coal and conglomerate, with deposits of Quaternary age alluvium present in the vicinity of Kroombit Creek.

Section 5: Callide Range (KP 313.75 to KP 354.75)

The geology of Section 5: Callide Range is presented in Figure 7.1 (Page 12 of 14 to Page 13 of 14).

The geology for this section is reported on the 'Monto' 1:250,000 scale geological sheet. This map indicates the geology to consist of Jurassic age Precipice Sandstone composed of quartz sandstone, siltstone, shale and coal which in turn overlie the Jurassic Callide Coal measures consisting of siltstone, shale, conglomerate, coal and intermediate volcanics. Northwest of the Rainbow Creek Fault the alignment moves laterally into Early Carboniferous age Three Moon Conglomerate consisting not only of conglomerate but acidic and intermediate lava, tuff, agglomerate, sandstone, siltstone and mudstone and then the Triassic age Gallow Pains Tonalite. Quaternary age alluvium of clay, silt, sand and gravel overlay the Tonalite in the north east. Igneous dyke structures are indicated towards the north of the proposed pipeline alignment.

Section 6: East of Callide Range to Kangaroo Island (KP 354.75 to KP 406.25)

The geology of Section 6: East of Callide Range to Kangaroo Island is presented in Figure 7.1 (Page 13 of 14 to Page 14 of 14).

The geology of this section is reported on the 'Monto' and 'Rockhampton' 1:250,000 scale geological sheets and is indicated to predominately consist of early and middle Devonian age Mount Holly Beds comprised of siltstone, mudstone, sandstone, limestone, conglomerate and tuff. Lower Permian age Youlambie Conglomerate including conglomerate, as well as sandstone, mudstone and rhyolite flows is mapped as present in the north east of the section. Quaternary Holocene age alluvium composed of gravel, sand, silt and clay locally overlie the Mount Holly Beds and Youlambie Conglomerate. The proposed GTP alignment crosses a number faults mapped to follow a north west to southeast trend.

7.3.2 Topography and geomorphology

The topographical and geological features of each of the six sections along the Mainland GTP RoW are provided below. Topography for each section is illustrated in Figure 7.2.

Section 1: Fairview to Top Escarpment

The topography of Section 1: Fairview to Top Escarpment is presented in Figure 7.2 (Page 1 of 14 to Page 2 of 14).

The Mainland GTP RoW, shown on Figure 7.2 commences at KP 0 in the dissected plateau country of the Great Dividing Range to the south of Hutton Creek, located approximately 38 km east northeast of Injune. The topography on the plateau of the Jurassic sandstone rock types comprises locally near flat to undulating, in places strongly undulating to low hilly uplands with approximate surface levels ranging between relative level RL 370 m Australian Height Datum (AHD) at its southern end to RL 530 m AHD. The plateau is cut in many places by steep-sided scarps and ravines within which the soils are mostly sandy surface duplex soils or uniform loamy soils or gradational red and yellow earth soils. These soils are often very shallow and stony, with areas of sandstone rock outcrop on the upper margins of the plateau and on the steeper bounding scarp slopes.



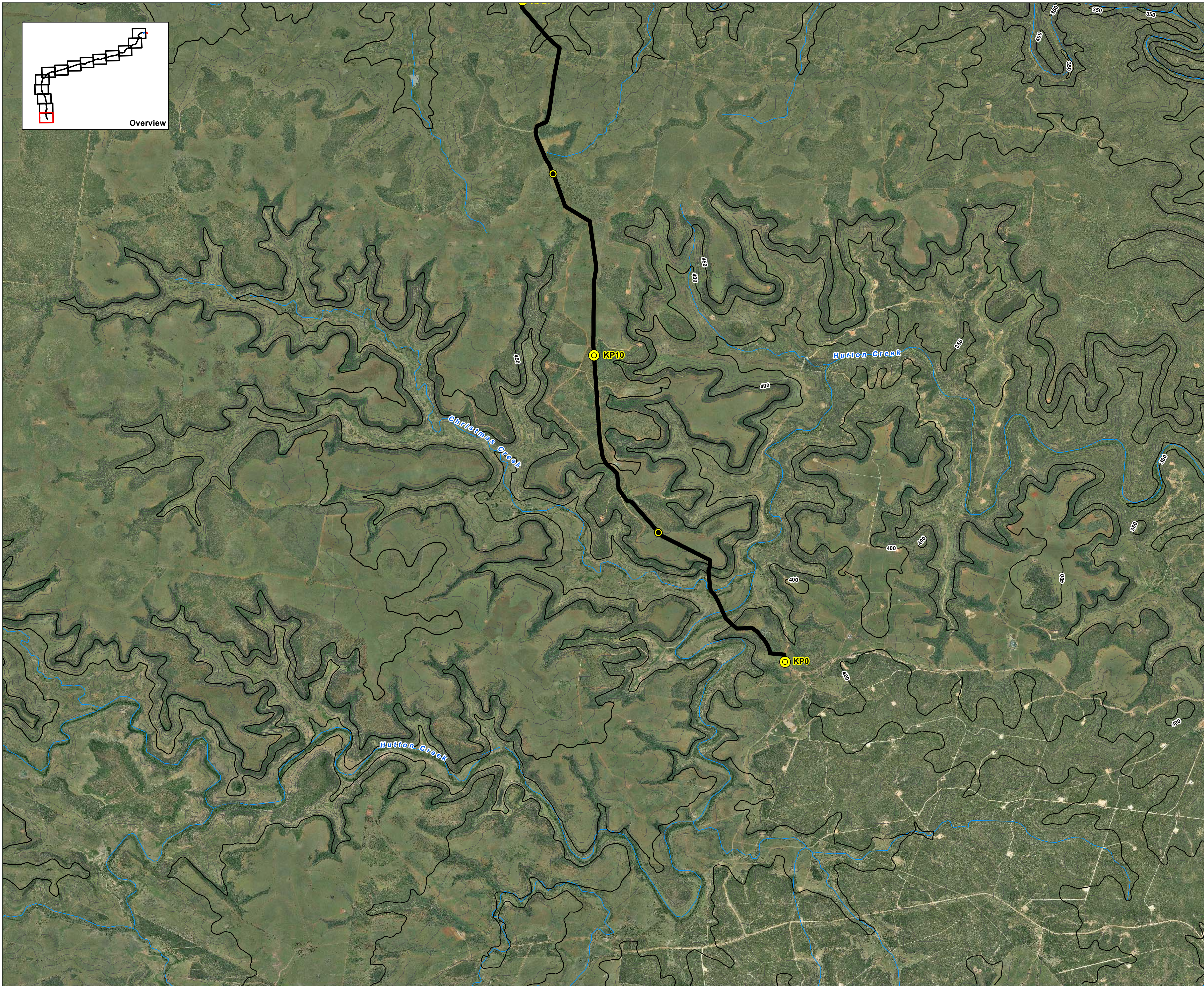
Mainland GTP EM Plan

- Gas Transmission Pipeline (GTP)
- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

- Kilometre Post Distance Marker
- 10km
- 5km

- Contour
- 50m
- 10m
- Rail
- Watercourse

Note: All figures should be reviewed in conjunction with Table 7.1 "Generic Key to the identification of Terrain Units", URS 2009.



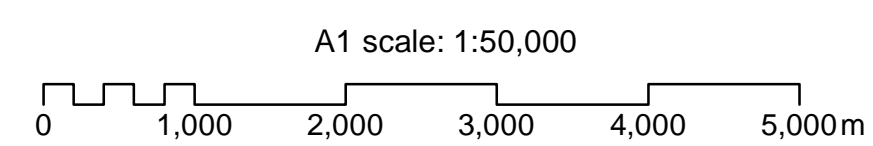
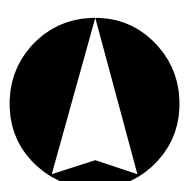
Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Topography: Department of Management and Resource Management, March 2011.

Topography Figure 7.2 (Page 1 of 14)

Date: 11/04/2011

Version: b

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Map by: RB



GLNG No: 3381-40-0406
 Coordinate system: GCS_GDA_1994



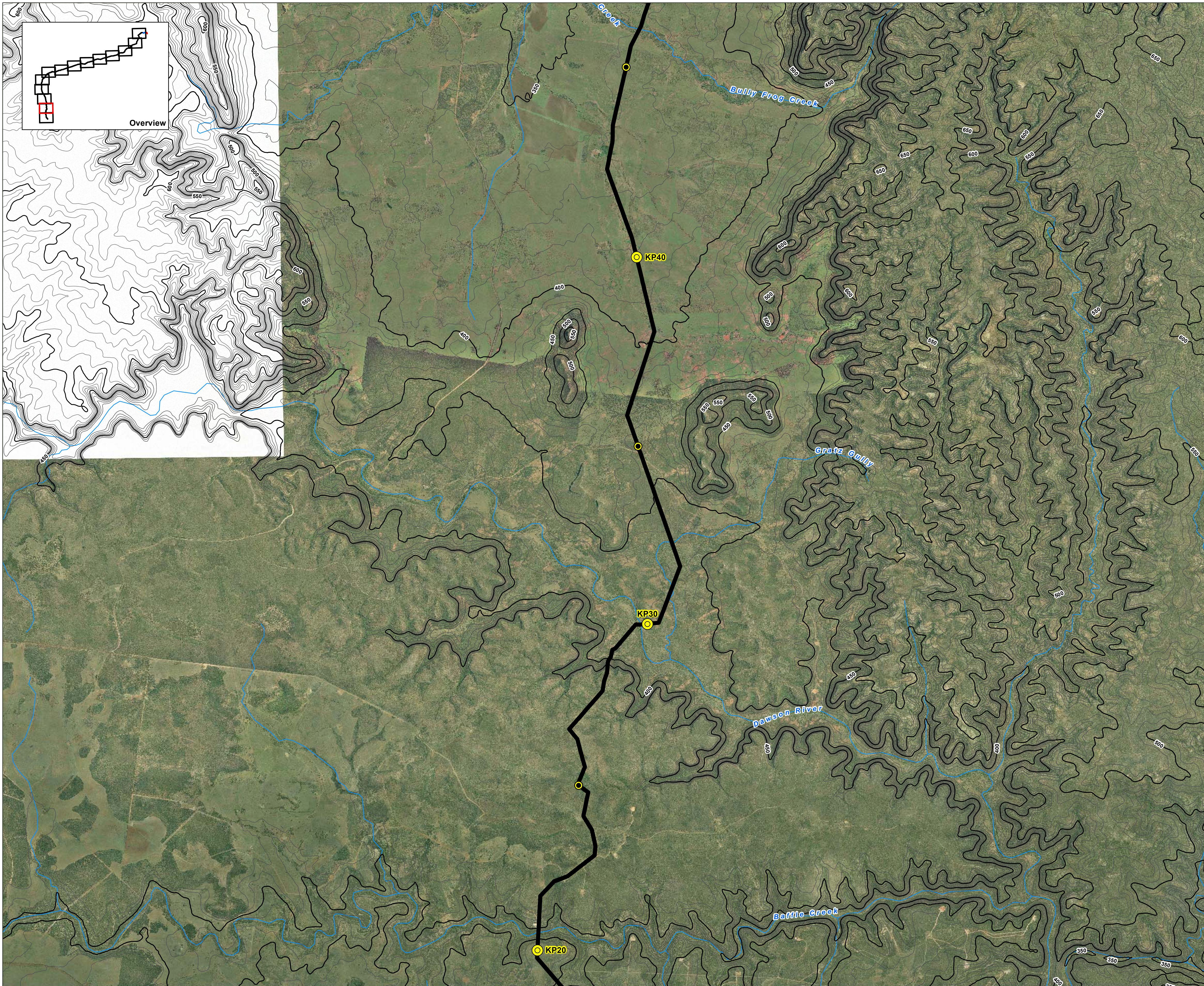
Mainland GTP EM Plan

- Gas Transmission Pipeline (GTP)
 - Mainland GTP EM Plan
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 - Curtis Island GTP EM Plan

- Kilometre Post Distance Marker
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- Contour
 - 50m
 - 10m
- Rail
- Watercourse

Note: All figures should be reviewed in conjunction with Table 7.1 "Generic Key to the identification of Terrain Units", URS 2009.

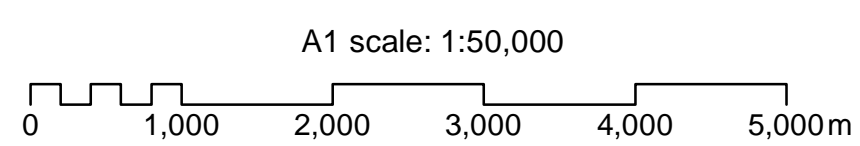
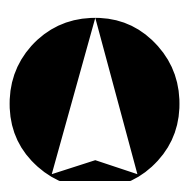


Source:
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 Topography: Department of Management and Resource Management, March 2011.

Topography
Figure 7.2 (Page 2 of 14)

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Map by: RB



GLNG No: 3381-40-0406
 Coordinate system: GCS_GDA_1994



Mainland GTP EM Plan

- Gas Transmission Pipeline (GTP)
 - Mainland GTP EM Plan
 - Marine Crossing GTP EM Plan
 - Curtis Island GTP EM Plan
- Kilometre Post Distance Marker
 - 10km
 - 5km
- Contour
 - 50m
 - 10m
- Rail
- Watercourse

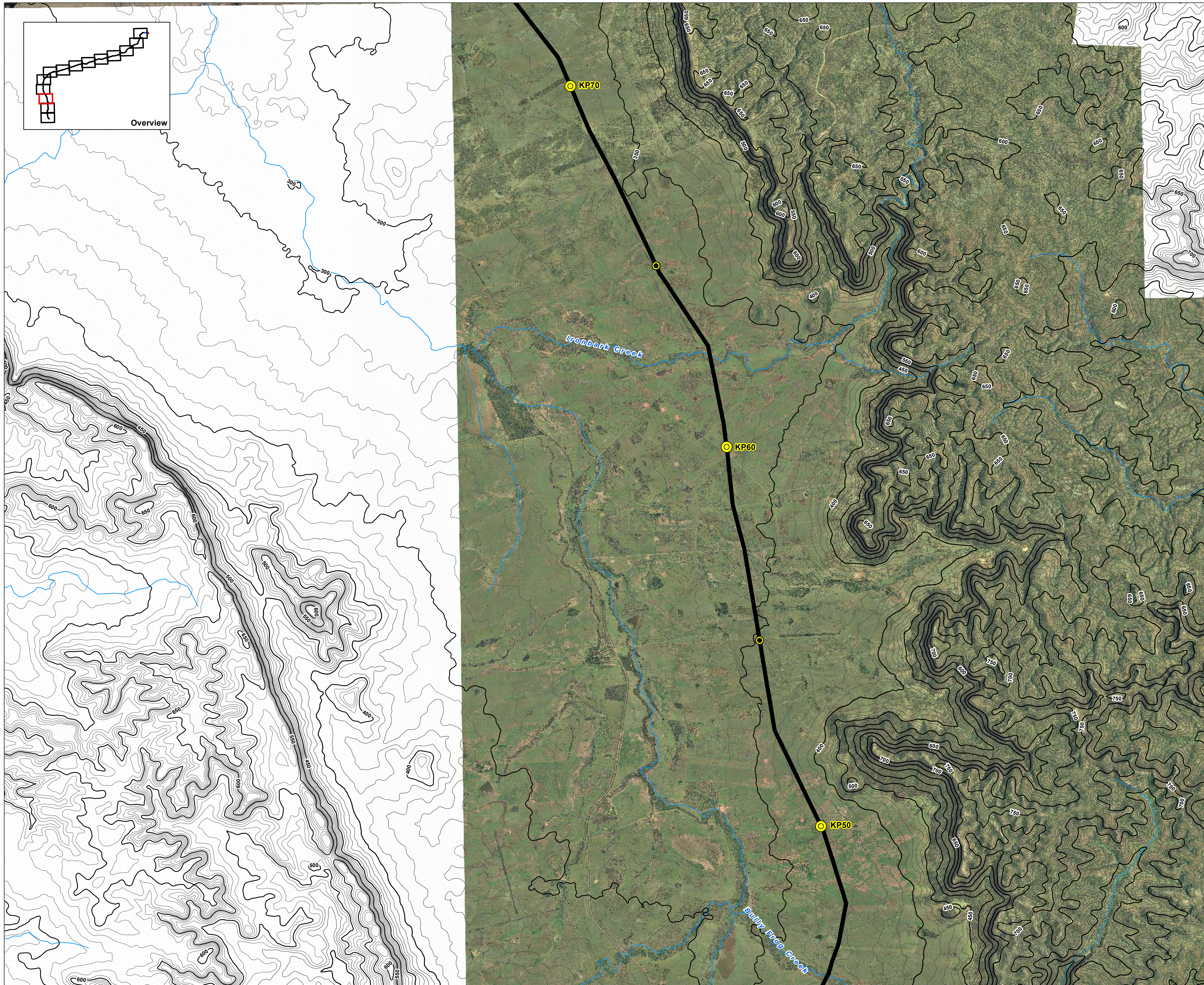
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Topography Figure 7.2 (Page 3 of 14)

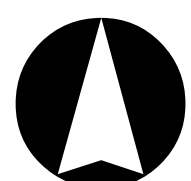
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Map by: RB



A1 scale: 1:50,000
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GLNG No: 3381-40-0406
Coordinate system: GCS_GDA_1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

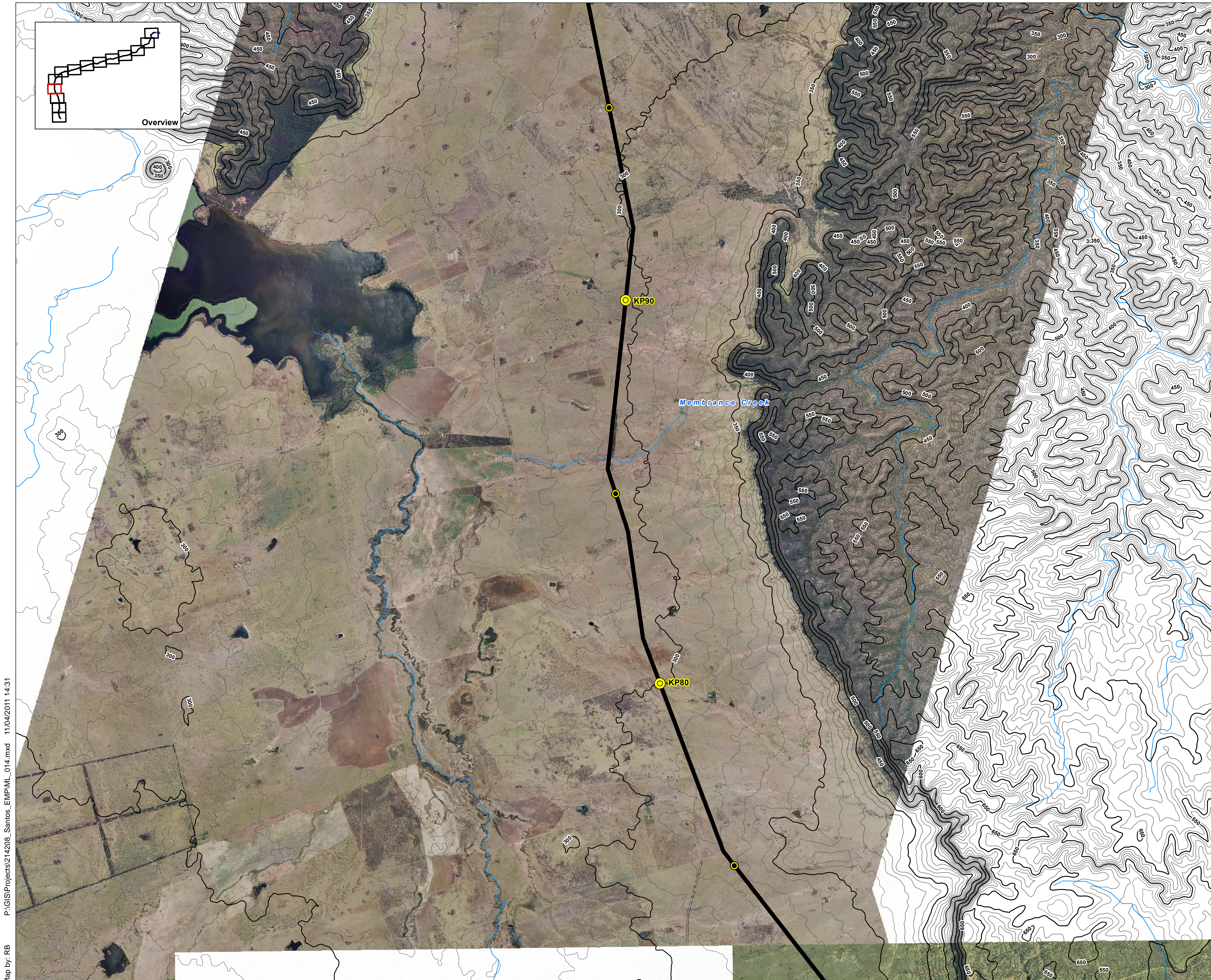
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- 5km

Contour

- 50m
- 10m
- Rail

- Watercourse

Note: All figures should be reviewed in conjunction with Table 7.1 "Generic Key to the identification of Terrain Units", URS 2009.



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Topography: Department of Management and Resource Management, March 2011.

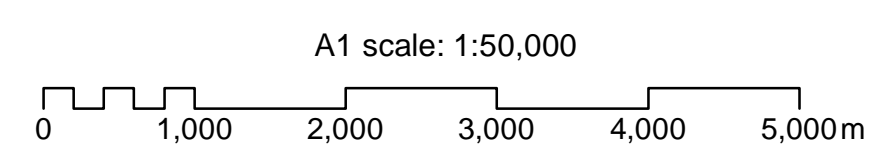
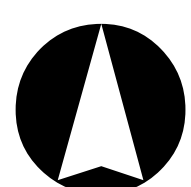
Topography Figure 7.2 (Page 4 of 14)

Date: 11/04/2011

Version: b

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Map by: RB



GLNG No: 3381-40-0406
Coordinate system: GCS_GDA_1994



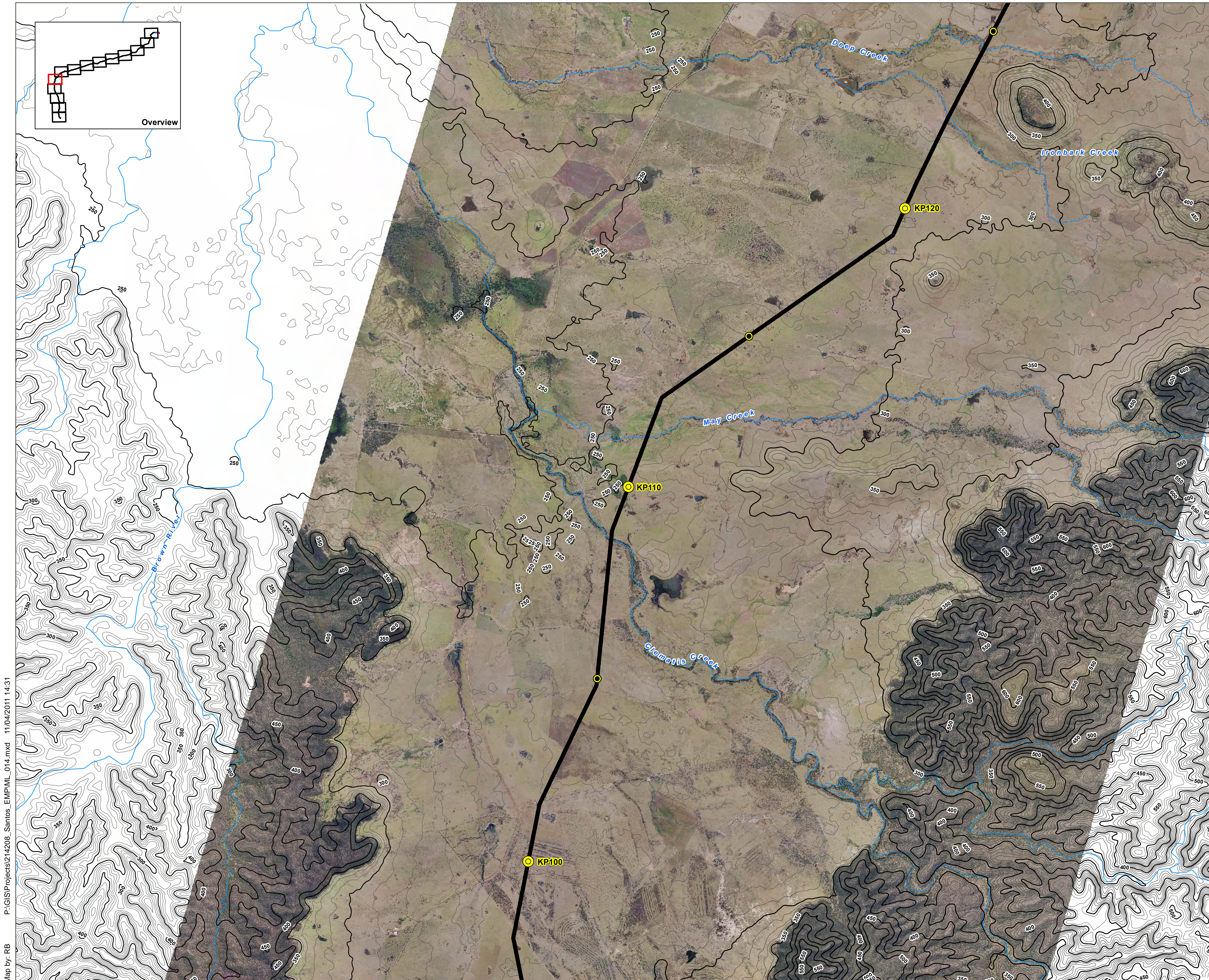
Mainland GTP EM Plan

- Gas Transmission Pipeline (GTP)
- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

- Kilometre Post Distance Marker
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- 5km

- Contour
- 50m
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- Rail
- Watercourse

Note: All figures should be reviewed in conjunction with Table 7.1 "Generic Key to the identification of Terrain Units", URS 2009.



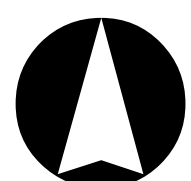
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Topography Figure 7.2 (Page 5 of 14)

Date: 11/04/2011

Version: b

Map by: RB P:\GIS\Projects\214208_Santos_EMP\ML_014.mxd 11/04/2011 14:31



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 Coordinate system: GCS_GDA_1994



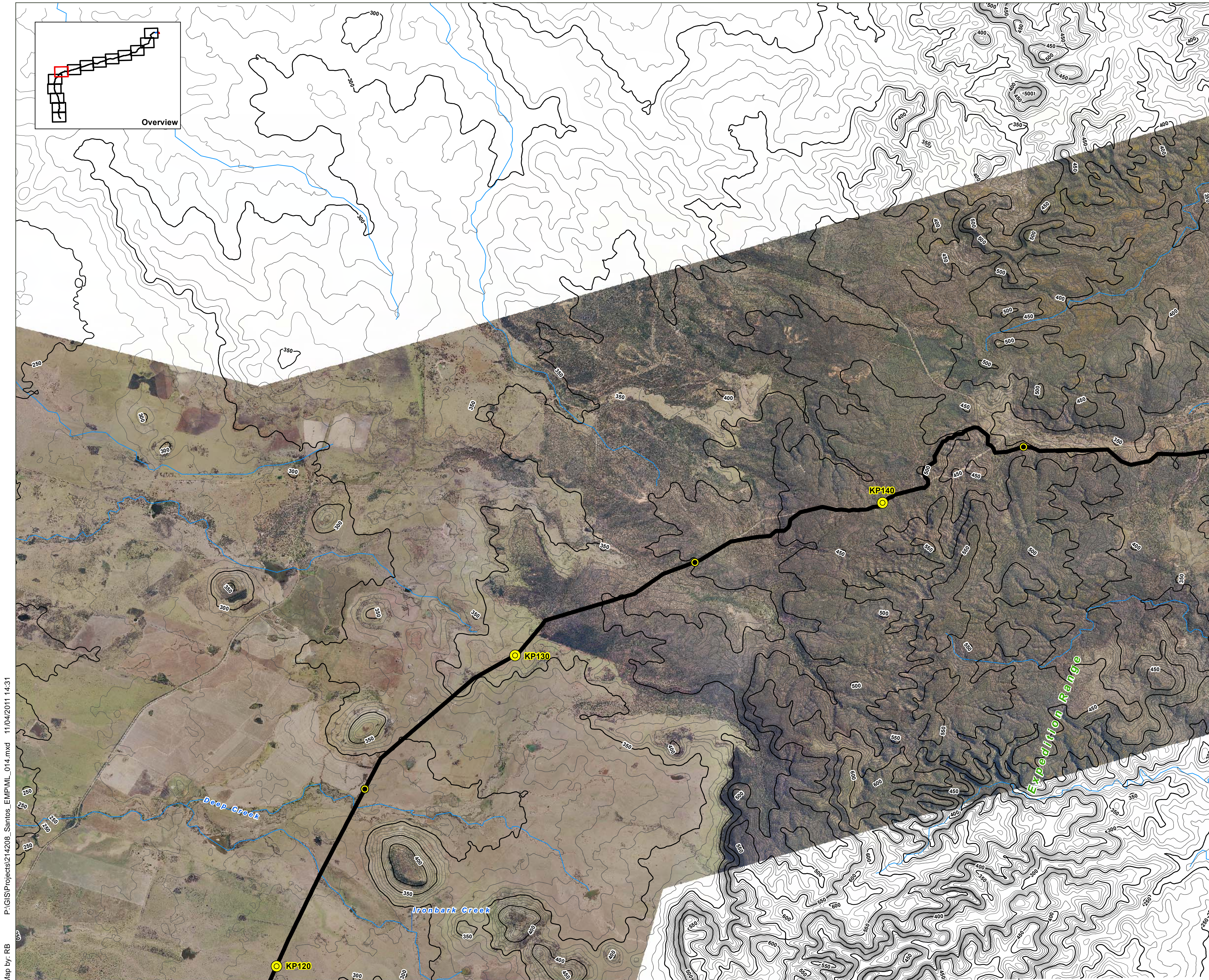
Mainland GTP EM Plan

- Gas Transmission Pipeline (GTP)
 - Mainland GTP EM Plan
 - Marine Crossing GTP EM Plan
 - Curtis Island GTP EM Plan

- Kilometre Post Distance Marker
 - 10km
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- Contour
 - 50m
 - 10m
- Rail
- Watercourse

Note: All figures should be reviewed in conjunction with Table 7.1 "Generic Key to the identification of Terrain Units", URS 2009.



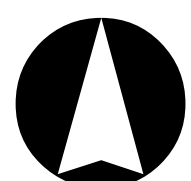
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Map by: RB

Source:
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Topography: Department of Management and Resource Management, March 2011.

Topography Figure 7.2 (Page 6 of 14)

Date: 11/04/2011

Version: b



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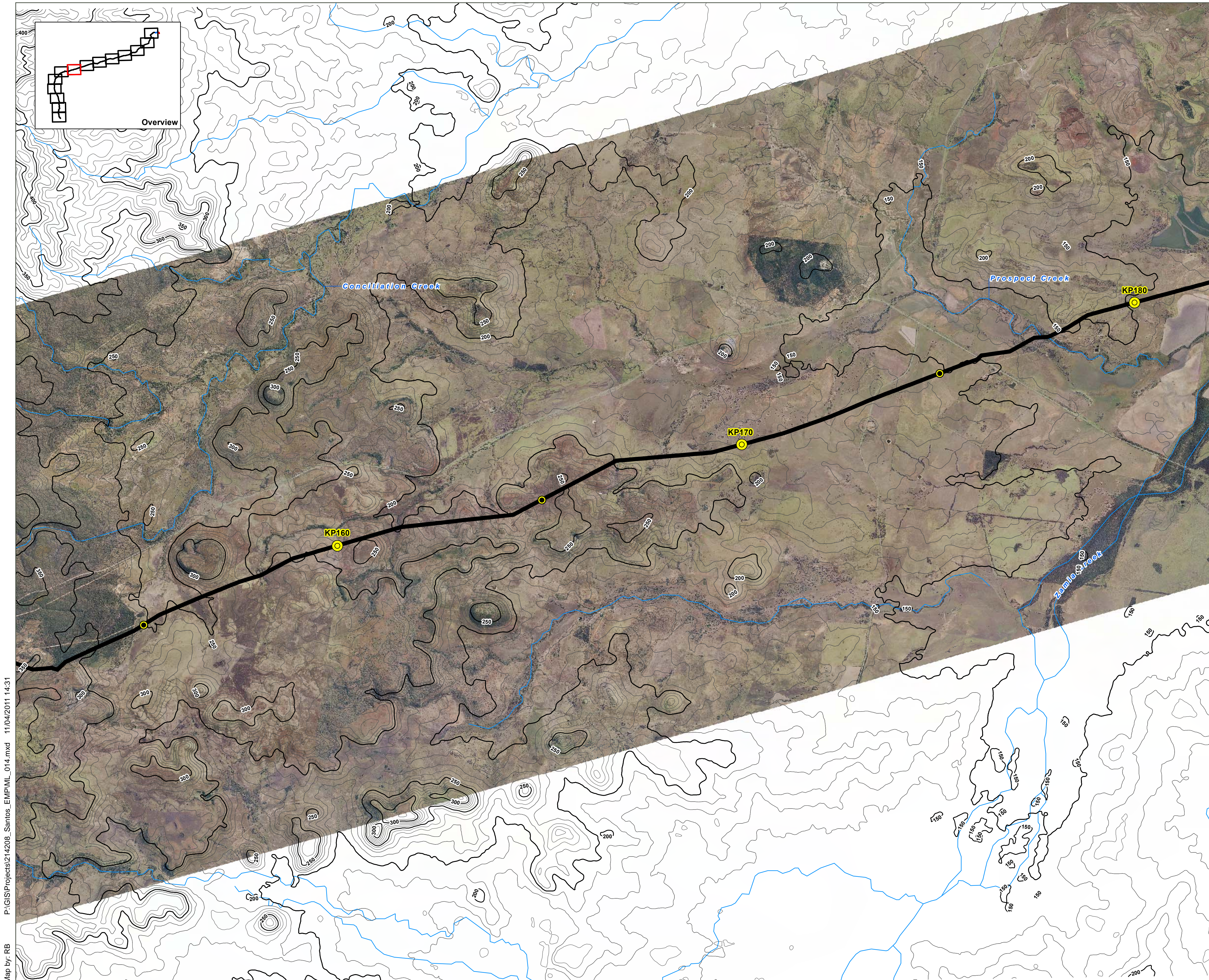
Mainland GTP EM Plan

- Gas Transmission Pipeline (GTP)
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 - Marine Crossing GTP EM Plan
 - Curtis Island GTP EM Plan

- Kilometre Post Distance Marker
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- Contour
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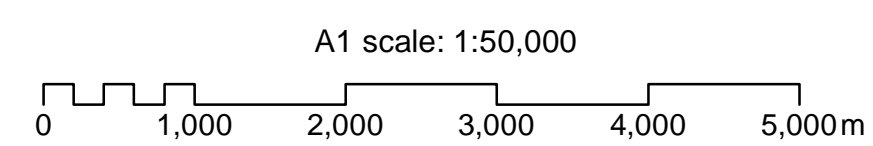
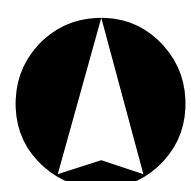
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Topography Figure 7.2 (Page 7 of 14)

Date: 11/04/2011

Version: b



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Coordinate system: GCS_GDA_1994



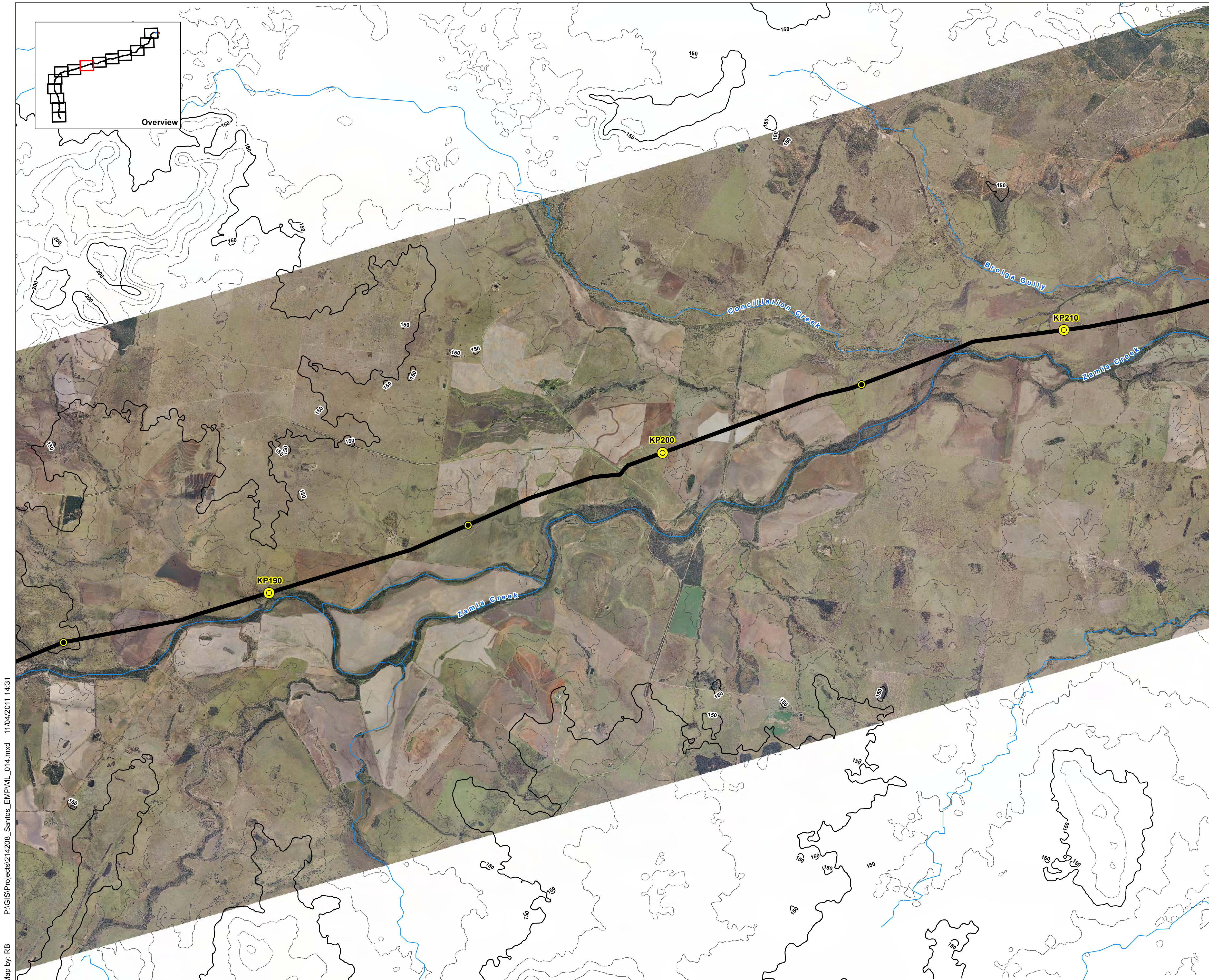
Mainland GTP EM Plan

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 - Curtis Island GTP EM Plan

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- Rail
- Watercourse

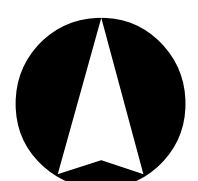
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Map by: RB

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Topography: Department of Management and Resource Management, March 2011.

Topography
Figure 7.2 (Page 8 of 14)



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Date: 11/04/2011

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Mainland GTP EM Plan

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Note: All figures should be reviewed in conjunction with Table 7.1 "Generic Key to the identification of Terrain Units", URS 2009.

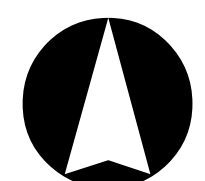


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Topography
Figure 7.2 (Page 9 of 14)



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Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
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Kilometre Post Distance Marker

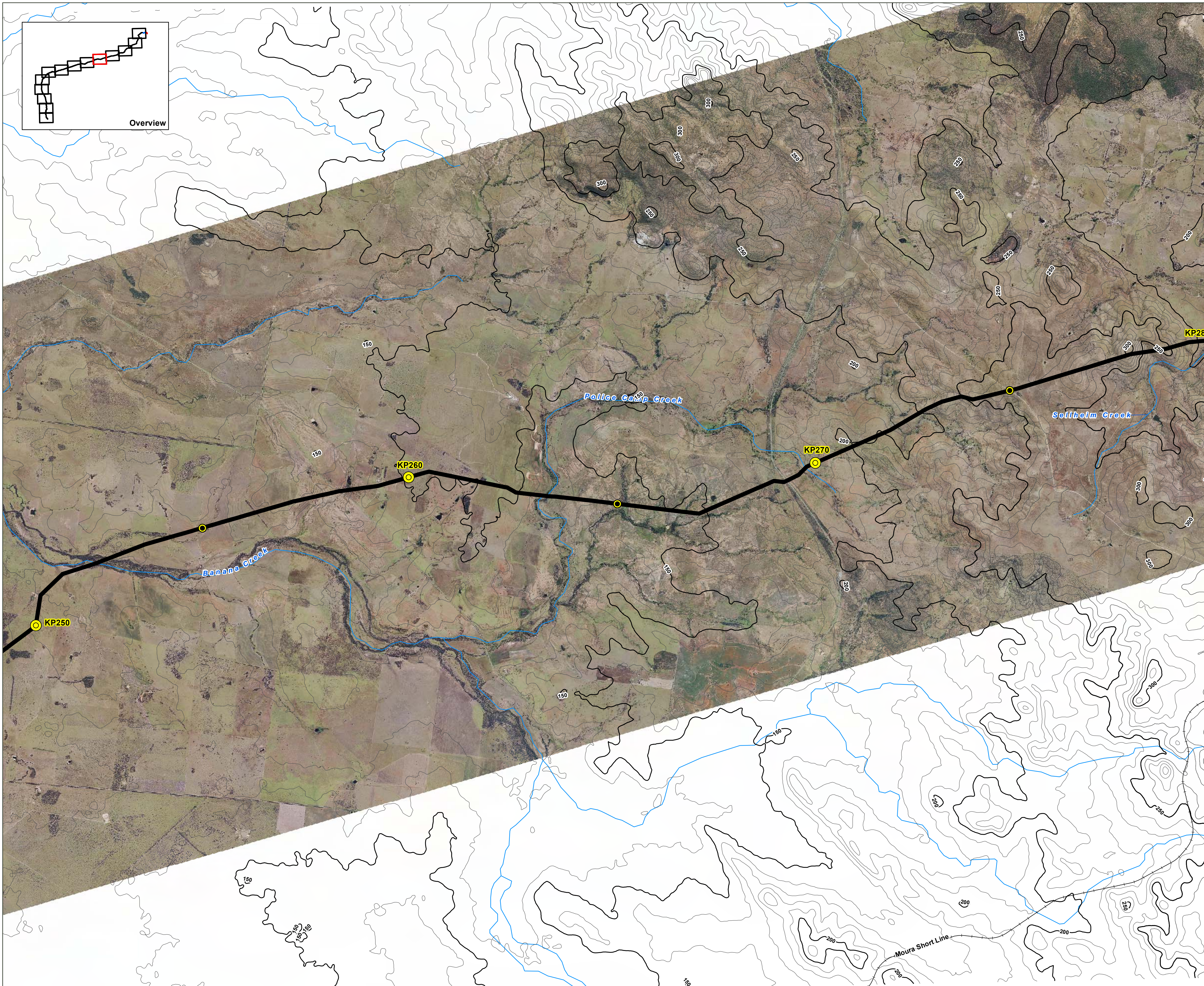
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Contour

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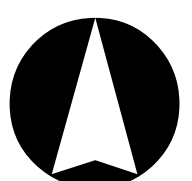
Topography Figure 7.2 (Page 10 of 14)

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Map by: RB



A1 scale: 1:50,000
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GLNG No: 3381-40-0406
Coordinate system: GCS_GDA_1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

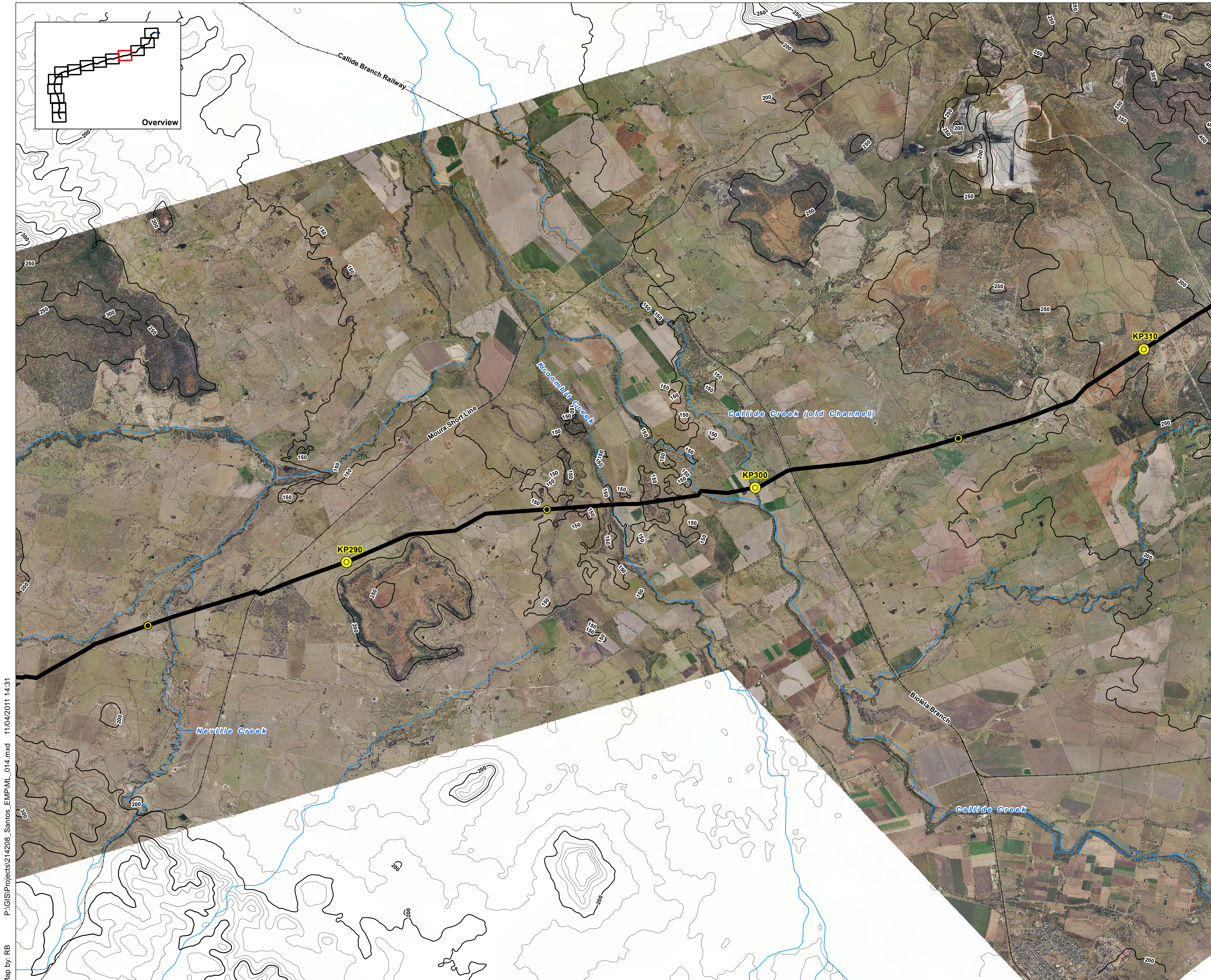
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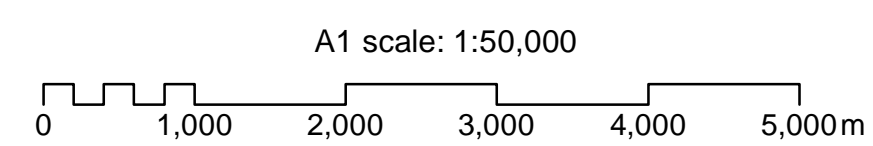
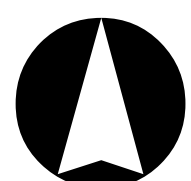
Topography Figure 7.2 (Page 11 of 14)

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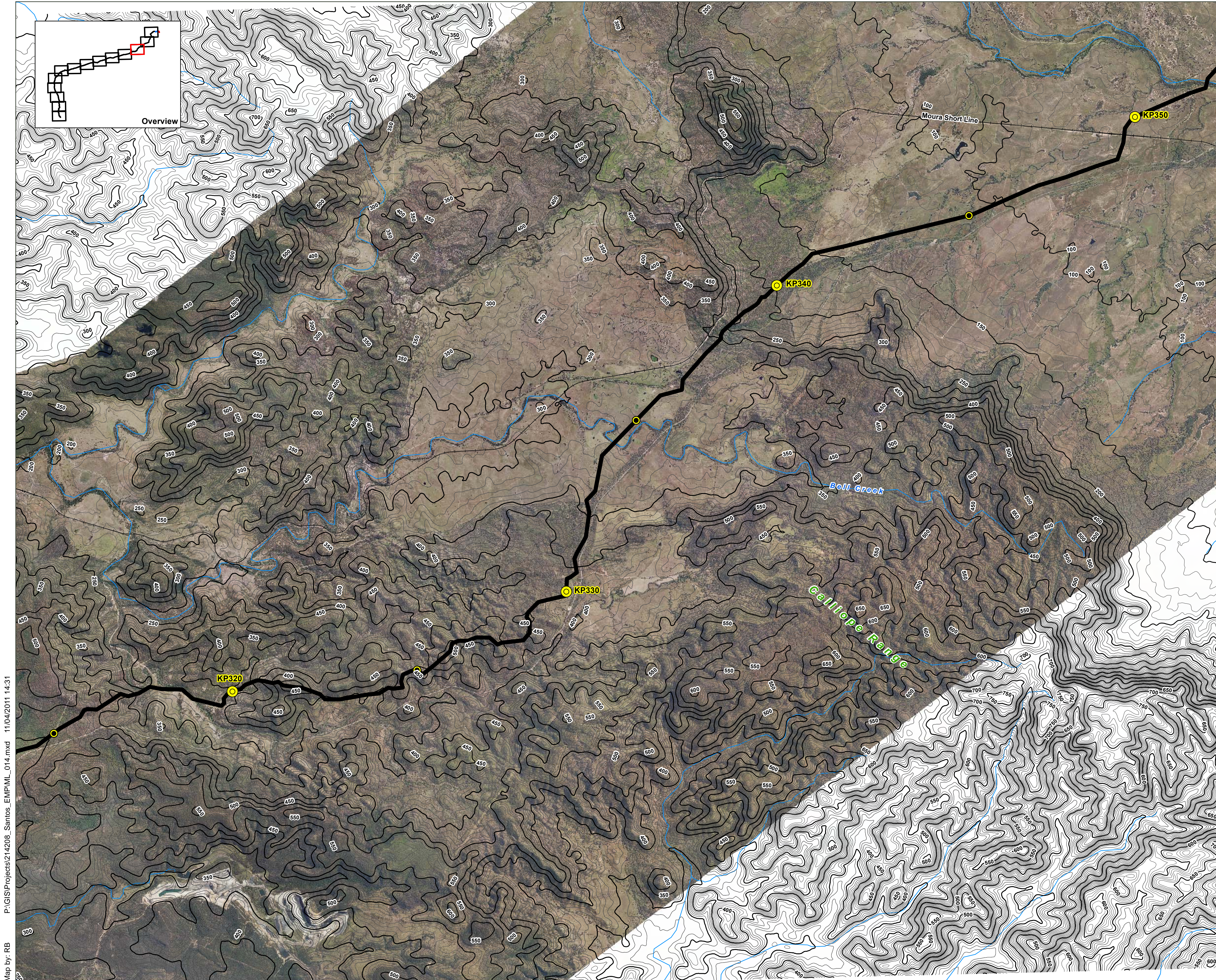
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Mainland GTP EM Plan

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 - 10km
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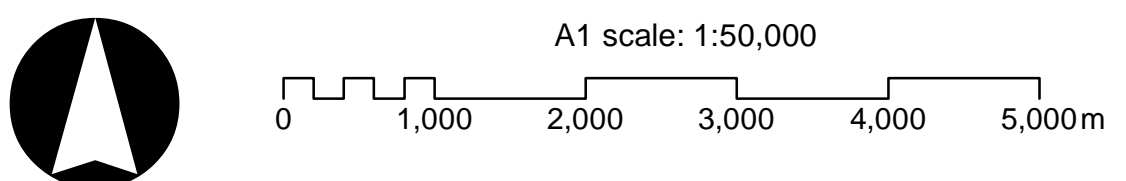


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 Topography: Department of Management and Resource Management, March 2011.

Topography
Figure 7.2 (Page 12 of 14)

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Map by: RB





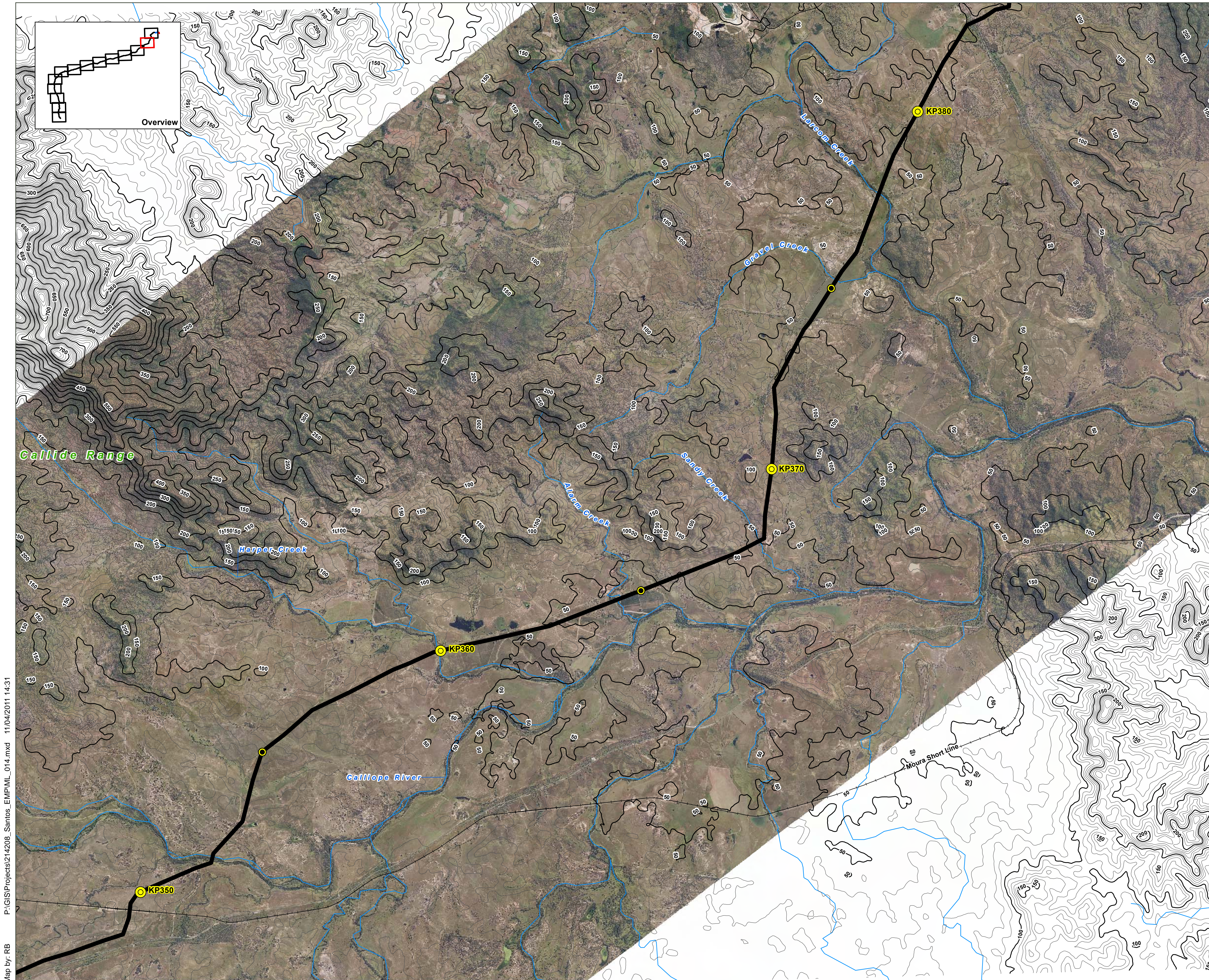
Mainland GTP EM Plan

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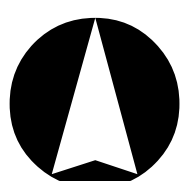
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Source:
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Topography: Department of Management and Resource Management, March 2011.

Topography
Figure 7.2 (Page 13 of 14)



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Date: 11/04/2011

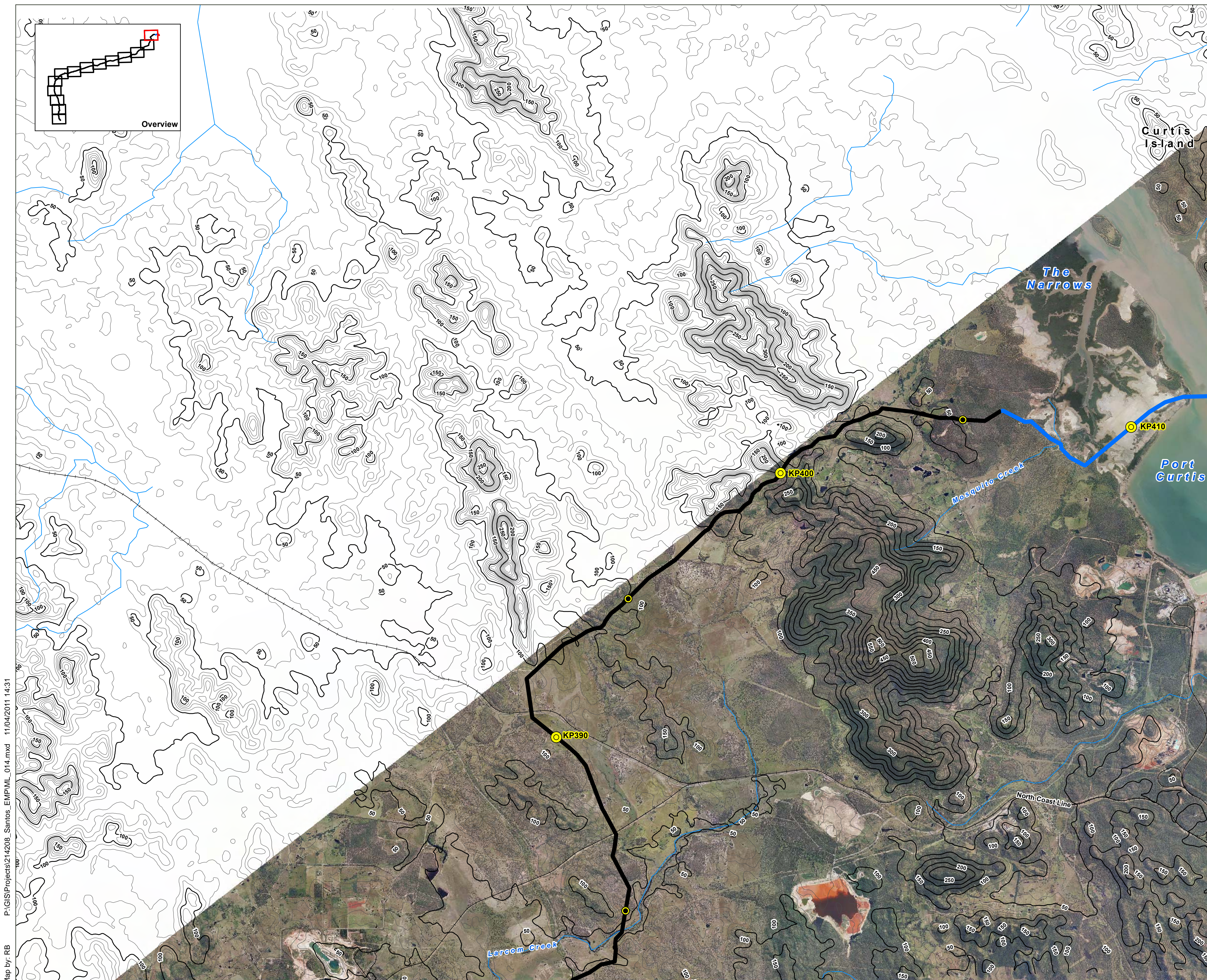
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Mainland GTP EM Plan

- Gas Transmission Pipeline (GTP)
 - Mainland GTP EM Plan
 - Marine Crossing GTP EM Plan
 - Curtis Island GTP EM Plan
- Kilometre Post Distance Marker
 - 10km
 - 5km
- Contour
 - 50m
 - 10m
- +— Rail
- Watercourse

Note: All figures should be reviewed in conjunction with Table 7.1 "Generic Key to the identification of Terrain Units", URS 2009.



Source:
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Topography: Department of Management and Resource Management, March 2011.

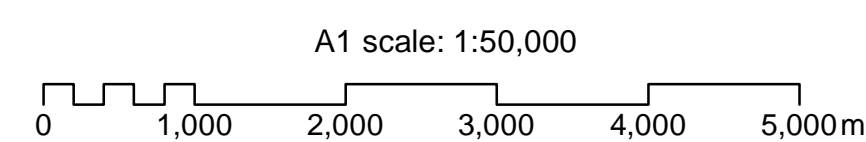
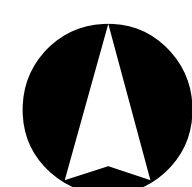
Topography Figure 7.2 (Page 14 of 14)

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Map by: RB



GLNG No: 3381-40-0406
Coordinate system: GCS_GDA_1994

Drainage of these dissected plateau uplands is generally in an easterly direction via Hutton Creek and Baffle Creek and by the upper reaches of the Dawson River, each of which are intersected by the Mainland GTP RoW in the vicinity of KP 2.25, KP 20.5 and KP 29.75 respectively. The Mainland GTP RoW descends from the upland plateau area via the northern bounding escarpment of the Carnarvon Range, which features near-vertical sandstone precipices with very steep to steep mid to lower slopes in sandstone, siltstone and mudstone rock types.

Section 2: Arcadia Valley

The topography of Section 2: Arcadia Valley is presented in Figure 7.2 (Page 2 of 14 to Page 6 of 14).

This section extends from the bottom of the escarpment (KP 28.25) to where the proposed Mainland GTP RoW meets the Expedition Range (KP 137.75). The Mainland GTP RoW crosses the narrow sandy floodplain of the upper reaches of the Dawson River and proceeds northward through the Arcadia Valley. The Arcadia Valley comprises locally near flat to gently undulating alluvial plains (~ RL 360 m AHD). Drainage flats occur in the vicinity of the crossing of Arcadia Creek; on the alluvial plains associated with Brown River and approaching the GTP crossing of Clematis Creek. Along the eastern margin of the valley, Cainozoic colluvial fan deposits containing some sandy-surfaced duplex soils and areas of medium to heavy clays, form a discontinuous gently to moderately sloping transition to the dissected footslopes of the Expedition Range (~RL 360 m AHD). The broad alluvial plains of the Brown River and other streams within the Arcadia Valley are dominated by cracking and non-cracking uniform clay soils. The Mainland GTP RoW includes a crossing of Dawson River.

Section 3: Expedition Range to East of Dawson Highway

The topography of Section 3: Expedition Range to East of Dawson Highway is presented in Figure 7.2 (Page 6 of 14 to Page 8 of 14).

In this section the Mainland GTP RoW changes direction to the east and commences a gradual ascent to a crossing of the Expedition Range (RL 360 m AHD) between KP 137.75 to KP 182.75 approximately. The main rock types in the Expedition Range include heavily fractured quartz-rich sandstone, conglomerate, siltstone and mudstone of the Triassic Clematis Group and the terrain types comprise steep high hilly to mountainous lands. The Mainland GTP RoW through the higher section of the range crossing is located in close proximity to the Dawson Highway. The terrain through this sector comprises steep to very steep dissected hilly lands including narrow sharp-crested rocky ridges and spurs with intervening sharply incised steep-sided gullies. Hill and ridge slopes also are present, typically in the range 30 to 50%, locally with sub-vertical scarps and rock benches. The steep and difficult descent of the Expedition Range contains many bare rocky areas and the steeper slopes often contain shallow stony soils underlain by weathered rock. The more gently sloping lower slopes are mostly underlain by siltstone and mudstone rock types and typically have shallow texture-contrast (duplex) soils with medium to heavy clay subsoils (Sodosols and Chromosols).

Section 4: East of Dawson Highway to North of Burnett Highway

The topography of Section 4: East of Dawson Highway to North of Burnett Highway is presented in Figure 7.2 (Page 9 of 14 to Page 11 of 14).

East of the Expedition Range, with the exception of a crossing of the Dawson Range from (RL 130 m AHD to RL 160 m AHD) between KP 182.75 to KP 313.75, the area comprises of a narrow low range of hills developed on Triassic Clematis sandstone rock types, the Mainland GTP RoW traverses mainly undulating plains and lowlands developed on a variety of rock types including, Triassic sandstone, Tertiary volcanics, Tertiary sediments, Cainozoic sediments and Permian sediments. Extensive areas of Quaternary alluvial deposits also occur in the crossings of the floodplains and stream channels of Conciliation Creek, Zamia Creek, Mimosa Creek, the Dawson River, Kianga Creek and Banana Creek. In general, all of these areas contain large areas of mainly cracking clay soils and non-cracking clays (Vertosols and Dermosols), with sandy surface texture-contrast soils (Sodosols) also occurring.

Continuing east, the Mainland GTP RoW crosses to the south of the Cooper Range (up to RL 260 m AHD) which comprises of strongly undulating to low rounded hilly lands with slopes mostly in the range 5 to 12%, locally up to 25%, developed on Permian volcanic rocks. Following the Cooper Range, the pipeline continues east, crossing more deeply dissected steeper hilly lands with broadly rounded crestal areas and hill and ridge slopes between 20 to 35% which are underlain by volcanoclastic rocks of the Carboniferous Torsdale Volcanics geological regime. These areas mostly have shallow to medium deep red and brown duplex soils (Chromosols and Sodosols) and shallow gravelly gradational and uniform clay soils (Rudosols and Dermosols) on the steeper and upper parts of slopes and medium deep cracking clays and loamy surface alkaline duplex soils on the lower slopes and valley floors.

From here, the Mainland GTP RoW traverses undulating plains underlain by Tertiary sediments and gently to moderately inclined foot slopes of local low flat-topped hills of the Tertiary land surface and the lower slopes of low benched hills developed on Jurassic Precipice Sandstone. Within this sector, the GTP RoW crosses undulating alluvial plains and the floodplains of Kroombit Creek and Callide Creek. The dominant soils within this section comprise mainly of cracking and non-cracking clays (Vertosols and Dermosols) on the lowlands, with sandy surface duplex soils and shallow uniform sandy soils on the lower slopes of the low hilly rises.

Crossings include Dawson River, Leichardt Highway, Burnett Highway, Moura short line railway and Callide railway.

Section 5: Callide Range

The topography of Section 5: Callide Range is presented in Figure 7.2 (Page 12 of 14 to Page 13 of 14).

Continuing in an easterly direction, apart from a moderately steeply incised crossing of Bell Creek, the corridor traverses steep dissected high hilly lands of the Callide Range (RL 450 m AHD) with slopes mostly in the range 25 to 50% developed on Permian volcanic rocks and Devonian sedimentary rock sequences. These areas have mainly shallow gravelly clays and loams (Dermosols and Kandosols) and rock outcrop is common. Continuing east, the terrain comprises mainly strongly undulating lands with areas of low rounded hills and rises, developed on a range of Permian intrusive (granitic) rocks, which give rise to a range of medium deep sandy soils (Rudosols and Tenosols) and mainly yellow-brown sandy surface duplex soils (Chromosols and Kurosols). Within this section, the Mainland GTP RoW descends through the steep rocky eastern fault-line escarpment of the Callide Range. Further to the east, the GTP RoW crosses a broad tributary stream floodplain of the Calliope River. Cracking clay soils (Vertosols) and thin loamy surface duplex soils (Chromosols and Sodosols) occur on the floodplains of the Calliope River (RL 70 m AHD) and its major tributaries throughout this sector.

Section 6: East of Callide Range to Marine Crossing GTP Point A

The topography of Section 6: East of Callide Range to Marine Crossing GTP Point A is presented in Figure 7.2 (Page 13 of 14 to Page 14 of 14).

Heading north from the Calliope River crossing (RL 30 m AHD) to approximately KP 419.25, the corridor traverses mostly along the footslopes of low hilly, hilly and higher hilly lands of the Larcom Range (RL 119 m AHD), which are underlain mainly by Silurian and Devonian volcanoclastic sedimentary rock types and some Permian volcanic rock types. The associated soil types in these areas consist mainly of shallow gravelly sandy loams and loams (Rudosols) with areas of rock outcrop and gradational or uniform shallow gravelly clay soils (Dermosols) on hill slopes and medium deep thin loamy surface duplex soils (Sodosols) on some gently inclined lower slopes. Some cracking clay soils and thin silt loamy surface duplex soils occur in intervening lower-lying areas of Quaternary alluvium in the valley flats.

7.3.3 Soil groups and soil types

Soil types in the Mainland GTP RoW have been assessed using Terrain Units to identify their occurrence and distribution.

Soil characteristics are strongly related to parent material, formation process and relief (McDonald et al., 1990). The dominant parent material in the Mainland GTP RoW is sedimentary rocks (as discussed in the geology section) as well as alluvium and colluvium. The variable topography and undulating relief has resulted in small pockets of variable soil types occurring across the Mainland GTP section.

Soil types in the Mainland GTP RoW have been determined from interpretation of available data, combined with field logs and visual interpretation from photographs of soil exposures undertaken during the geotechnical investigation by Coffey Geotechnics (2008). The assessment indicates soils in the Mainland GTP RoW can be separated into nine broad groups:

- Skeletal, rocky or gravelly soils (>60% coarse fragments) with sandy, silty, loamy or clayey soil matrix
- Sand soils, includes stratified alluvial soils, residual sand soils, earthy sands
- Coarse to medium-textured soils

- Medium-textured sandy, sandy loam or silt to clay
- Sand, loamy sand, sandy loam or loamy surface duplex soils
- Fine sandy, silty or clay loamy surface duplex soils
- Shallow uniform often gravelly fine-textured soils
- Shallow to medium to deep uniform fine-textured (cracking) clay soils
- Deep to very deep, very soft, uniform gradational or weak duplex soil

The soils are described using the Australian Soil and Land Survey Field Handbook (McDonald *et al.*, 1990). Soil groups have been classified using texture grade and key features, in accordance with the Australian Soil Classification (Isbell, 2002).

The soil groups along with their typical characteristics, constraints and properties presented in the EIS (URS, 2009) have been summarised below.

The occurrence and distribution of Soil Groups identified within the Mainland GTP RoW corridor and the Terrain Units in which they occur are shown in Figure 7.3 and are described below.

Soil Group 0 – Rocky outcrops, skeletal to shallow gravelly soils

Areas defined as Group 0 soils are generally areas of rocky outcrops, locally with skeletal to shallow, usually stoney or gravelly soils.

Soil Group 0 is mapped as only occurring in the Mainland GTP RoW in combination with other soil groups (namely groups 2, 4, 5, and 7). These rocky outcrops and shallow soils occur predominately near KP 0 to KP 30 (in association with soil Group 2), KP 140 at the Expedition Range (in association with soil group 2 and soil Group 5) and between KP 320 and KP 340 in the vicinity of the Callide Range.

Soil Group 1 – Shallow stony, gravelly and rocky soils

Group 1 soils comprise mainly shallow to medium deep stony, gravelly and rocky soils, typically with >60% coarse fragments in a sandy, silty, loamy or clayey soil matrix. Only one general soil type was identified within this group.

This soil type has been mapped as occurring in the vicinity of KP 30 near the Dawson River. In addition, soil Group 1 occurs in association with soil Groups 4, 5 and 6. Soil Group 1 is also mapped as occurring in combination with soil Group 4 in small areas of the Callide Range. It is also mapped as occurring along some drainage channels in the east of the Mainland GTP RoW in association with soil Group 6.

Soil Group 2 - Uniform or weakly gradational coarse-textured sandy soils

Group 2 soils comprise uniform or weakly gradational coarse-textured sandy soil profiles. Three soil type variants of this group have been identified as occurring within the Mainland GTP RoW area, these include:

Soil Type 2.1 - These soils occur mainly on the eroded plateau margins, on steep dissected scarps and hilly lands mainly in the sandstone plateau areas and comprise mainly shallow (<0.5 m) acidic sands and gravelly sands underlain by weathered sandstone or colluvium derived *in situ*. In terms of the Australian Soil Classification (ASC Isbell 1996), these soils are classified as Acidic Paralithic Rudosols.



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 10km
- 5km

Cadastre

Rail

Watercourse

Soil Group

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- 6 - Loamy or clayey duplex profiles with medium to heavy clay subsoils
- 7 - Shallow and deep uniform fine-textured (non-cracking) clay soils
- 8 - Shallow and deep uniform fine-textured (cracking) clay soils
- 9 - Tidal area soils
- Water

Combined Soil Group

- | | | |
|-----|-----|-----|
| 0-2 | 2-6 | 5-6 |
| 0-4 | 2-7 | 5-7 |
| 0-5 | 2-8 | 5-8 |
| 0-7 | 3-7 | 6-7 |
| 1-4 | 4-5 | 6-8 |
| 1-5 | 4-6 | 7-8 |
| 1-6 | 4-7 | 7-9 |
| 2-3 | 4-8 | |
| 2-5 | 5-1 | |

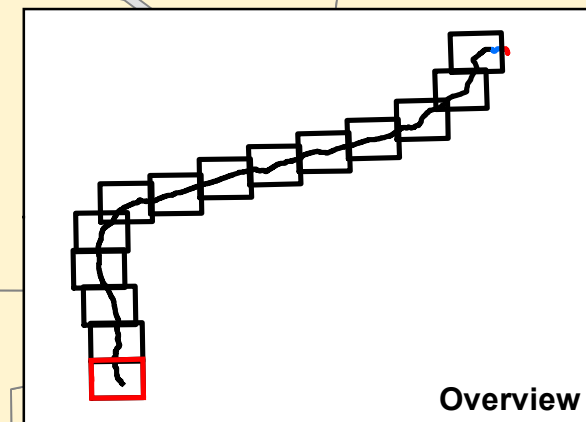
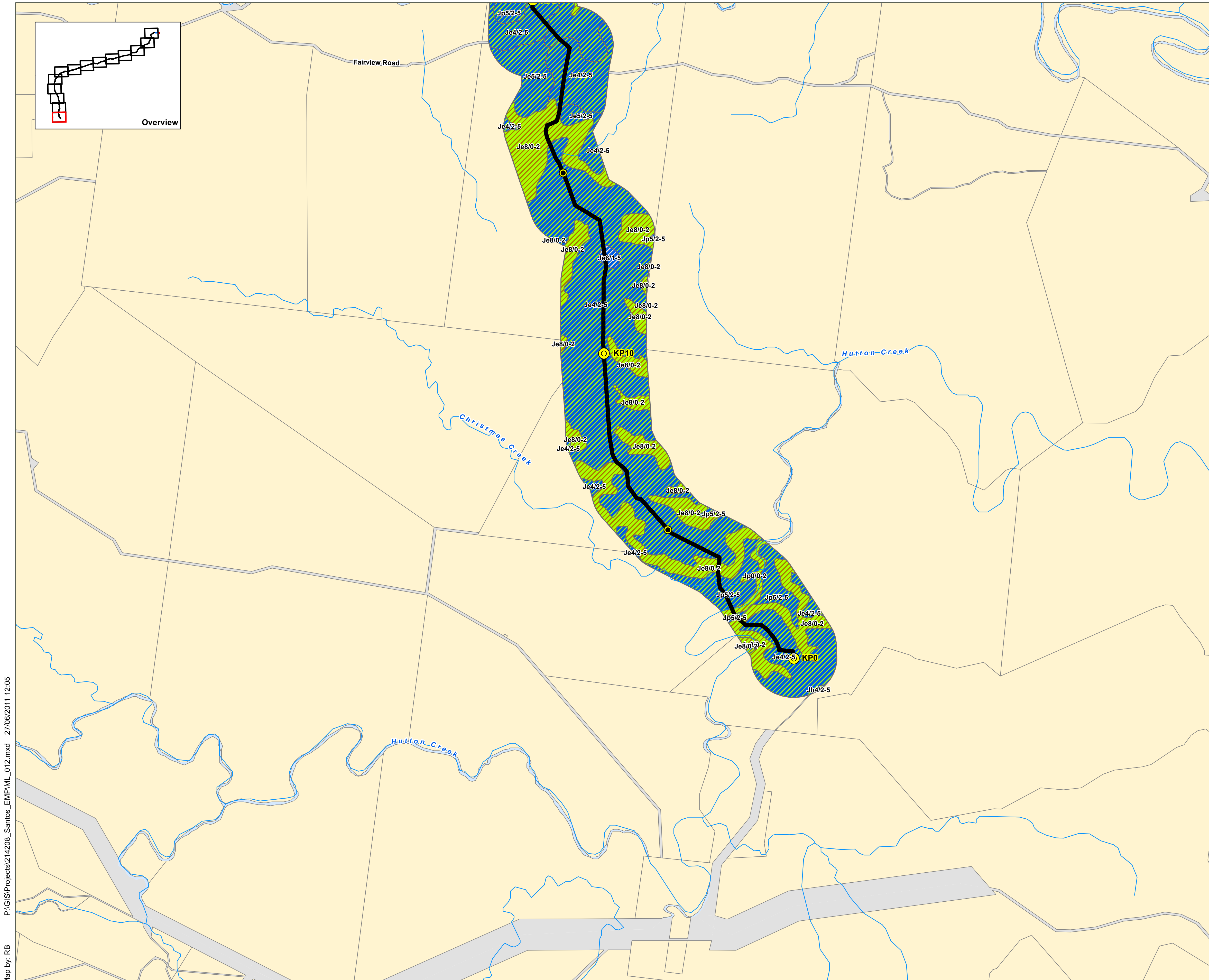
Note: All figures should be reviewed in conjunction with Table 7.1 "Generic Key to the Identification of Terrain Units", URS 2009.

Source:
Gas Transmission Pipeline (GTP): Santos, Jan 2011.
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GLNG Terrain Units: Supplementary EIS, URS, 2009.

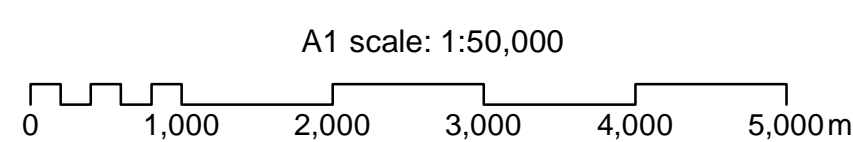
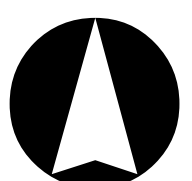
Soil Groups Figure 7.3 (Page 1 of 14)

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GLNG No: 3381-40-0407
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Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 10km
- 5km

Cadastre

Rail

Watercourse

Soil Group

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- 9 - Tidal area soils
- Water

Combined Soil Group

- | | | |
|-----|-----|-----|
| 0-2 | 2-6 | 5-6 |
| 0-4 | 2-7 | 5-7 |
| 0-5 | 2-8 | 5-8 |
| 0-7 | 3-7 | 6-7 |
| 1-4 | 4-5 | 6-8 |
| 1-5 | 4-6 | 7-8 |
| 1-6 | 4-7 | 7-9 |
| 2-3 | 4-8 | |
| 2-5 | 5-1 | |

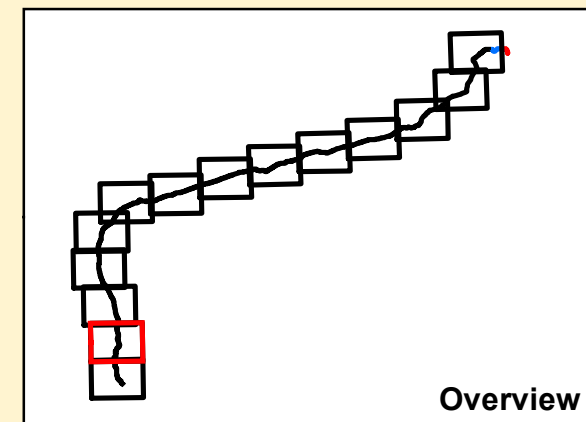
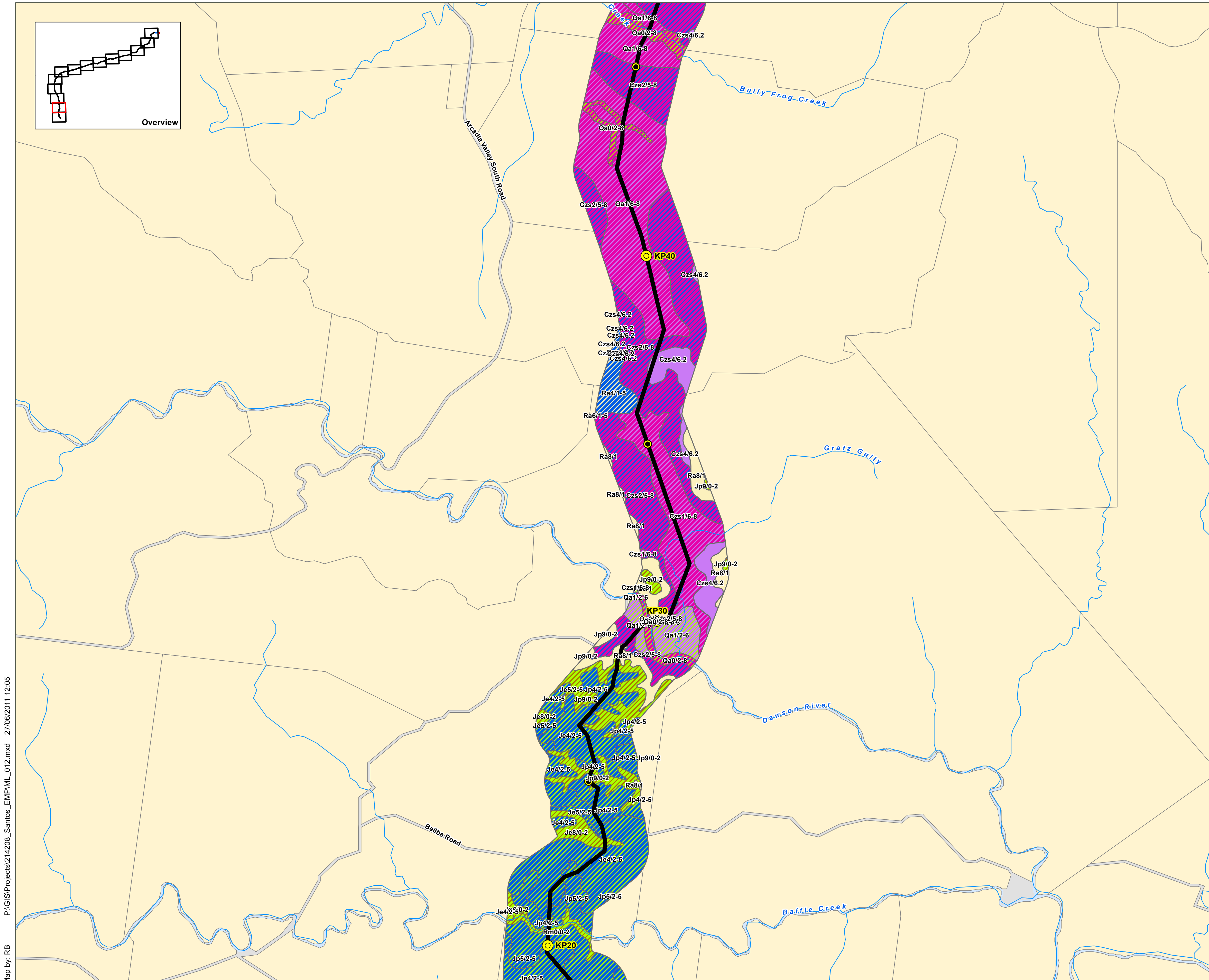
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Soil Groups Figure 7.3 (Page 2 of 14)

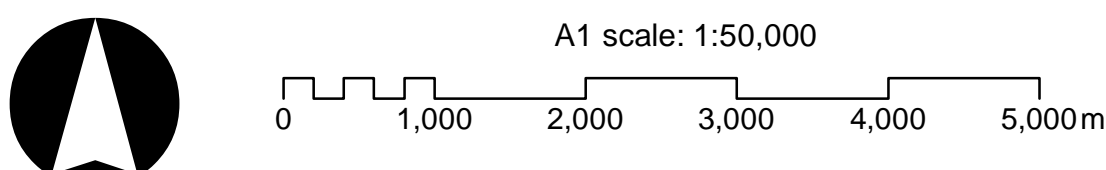
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Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

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- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 10km
- 5km

Cadastre

Rail

Watercourse

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- Water

Combined Soil Group

- | | | |
|-----|-----|-----|
| 0-2 | 2-6 | 5-6 |
| 0-4 | 2-7 | 5-7 |
| 0-5 | 2-8 | 5-8 |
| 0-7 | 3-7 | 6-7 |
| 1-4 | 4-5 | 6-8 |
| 1-5 | 4-6 | 7-8 |
| 1-6 | 4-7 | 7-9 |
| 2-3 | 4-8 | |
| 2-5 | 5-1 | |

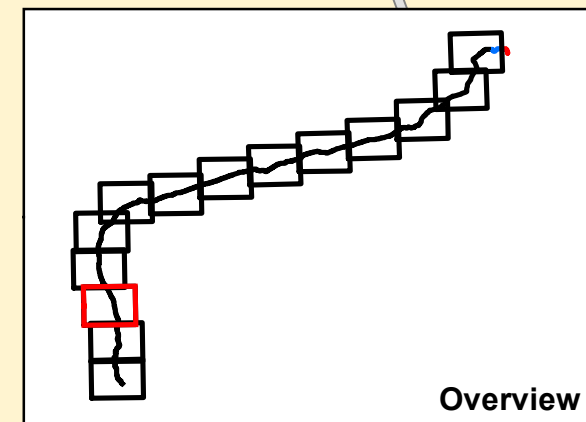
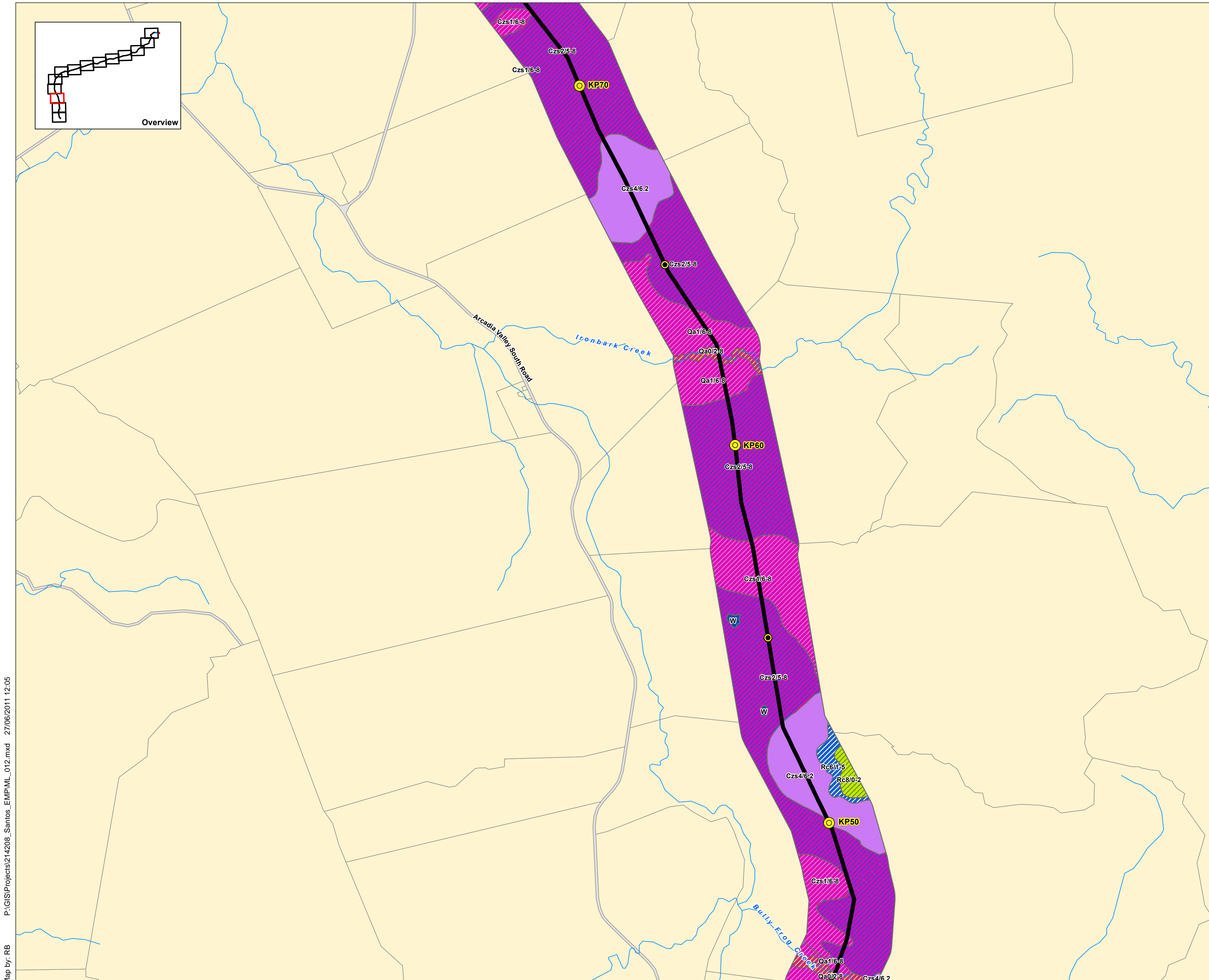
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Soil Groups Figure 7.3 (Page 3 of 14)

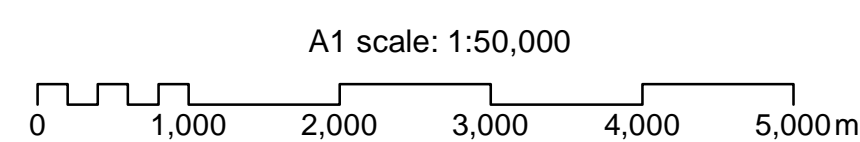
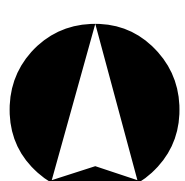
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Overview

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Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 10km
- 5km

Cadastre

Rail

Watercourse

Soil Group

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- 9 - Tidal area soils
- Water

Combined Soil Group

- | | | |
|-----|-----|-----|
| 0-2 | 2-6 | 5-6 |
| 0-4 | 2-7 | 5-7 |
| 0-5 | 2-8 | 5-8 |
| 0-7 | 3-7 | 6-7 |
| 1-4 | 4-5 | 6-8 |
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| 2-3 | 4-8 | |
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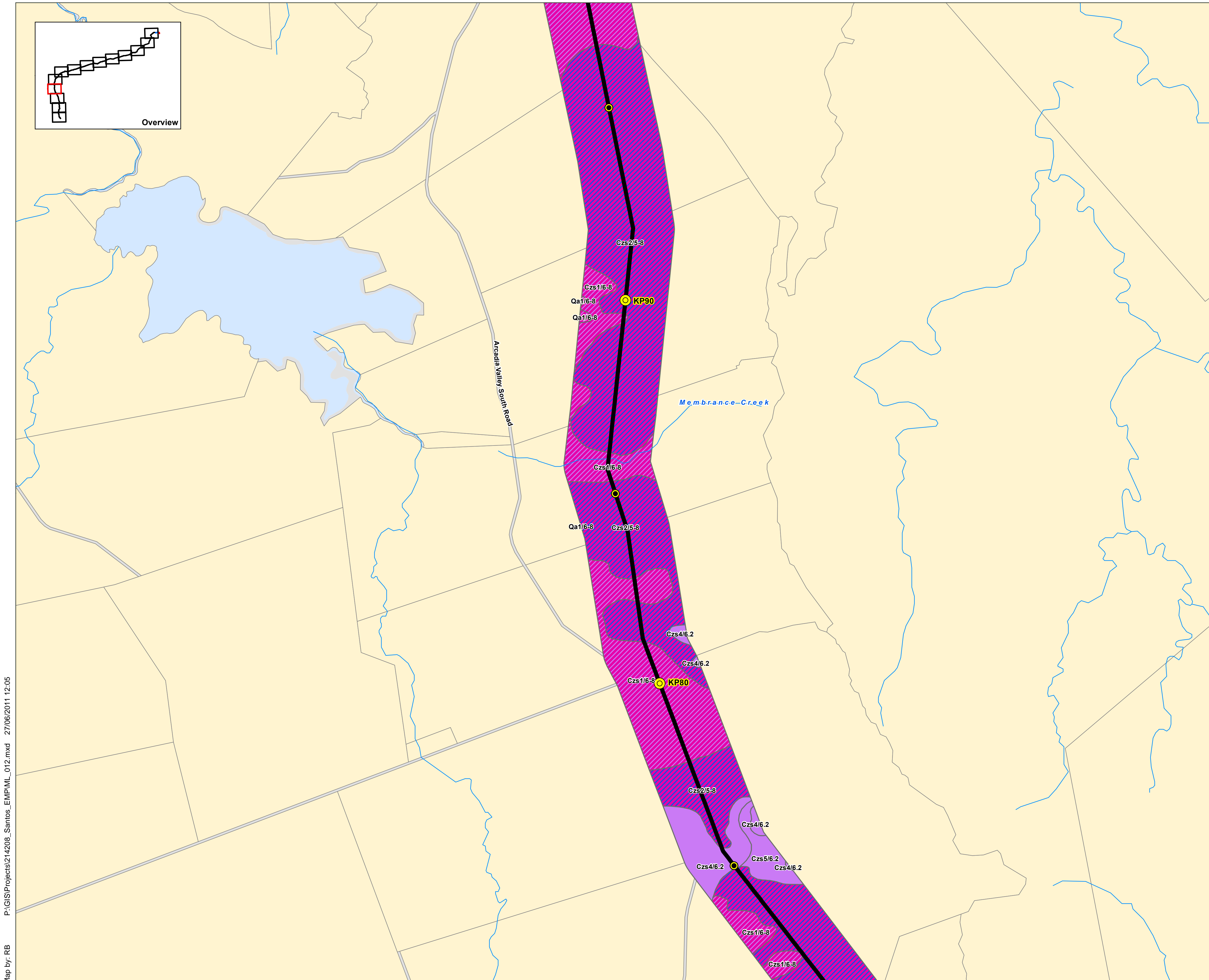
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Soil Groups Figure 7.3 (Page 4 of 14)

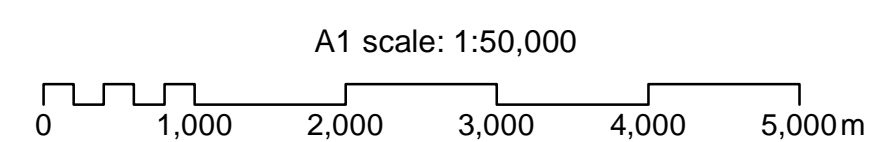
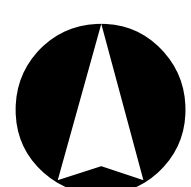
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Mainland GTP EM Plan

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Kilometre Post Distance Marker

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- 5km

Cadastre

Rail

Watercourse

Soil Group

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- Water

Combined Soil Group

- | | | |
|-----|-----|-----|
| 0-2 | 2-6 | 5-6 |
| 0-4 | 2-7 | 5-7 |
| 0-5 | 2-8 | 5-8 |
| 0-7 | 3-7 | 6-7 |
| 1-4 | 4-5 | 6-8 |
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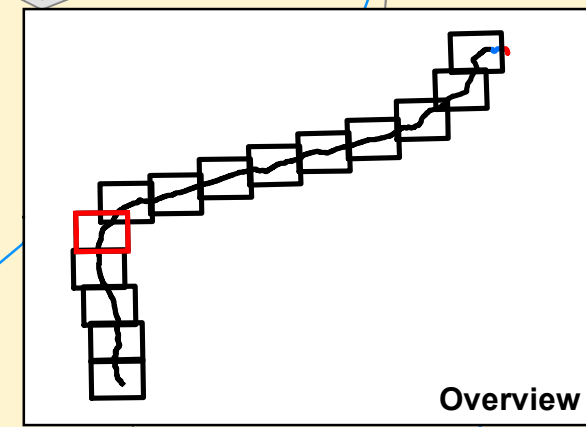
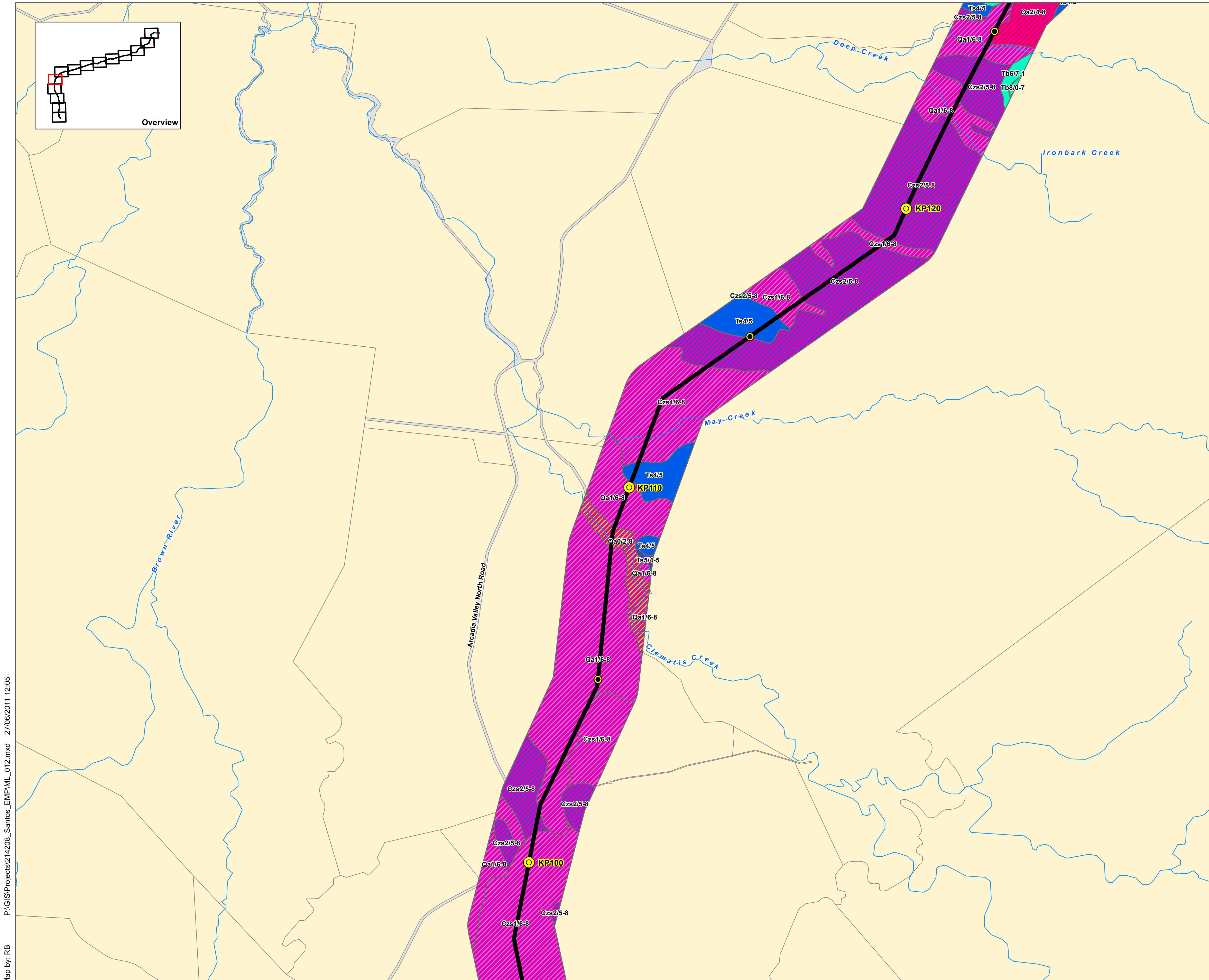
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Soil Groups Figure 7.3 (Page 5 of 14)

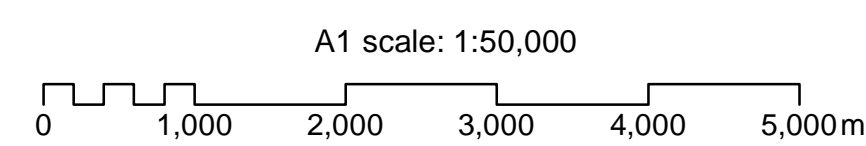
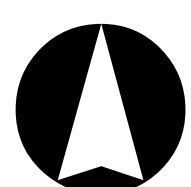
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Coordinate system: GCS_GDA_1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 10km
- 5km

Cadastre

- Rail
- Watercourse

Soil Group

- 0 - Rocky outcrops and skeletal soils
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- Water

Combined Soil Group

- | | | |
|-----|-----|-----|
| 0-2 | 2-6 | 5-6 |
| 0-4 | 2-7 | 5-7 |
| 0-5 | 2-8 | 5-8 |
| 0-7 | 3-7 | 6-7 |
| 1-4 | 4-5 | 6-8 |
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| 2-3 | 4-8 | |
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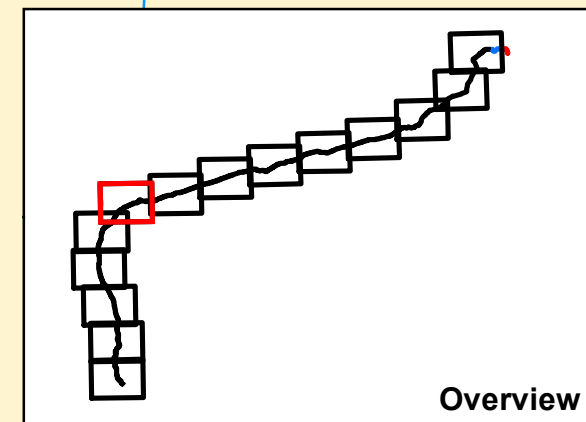
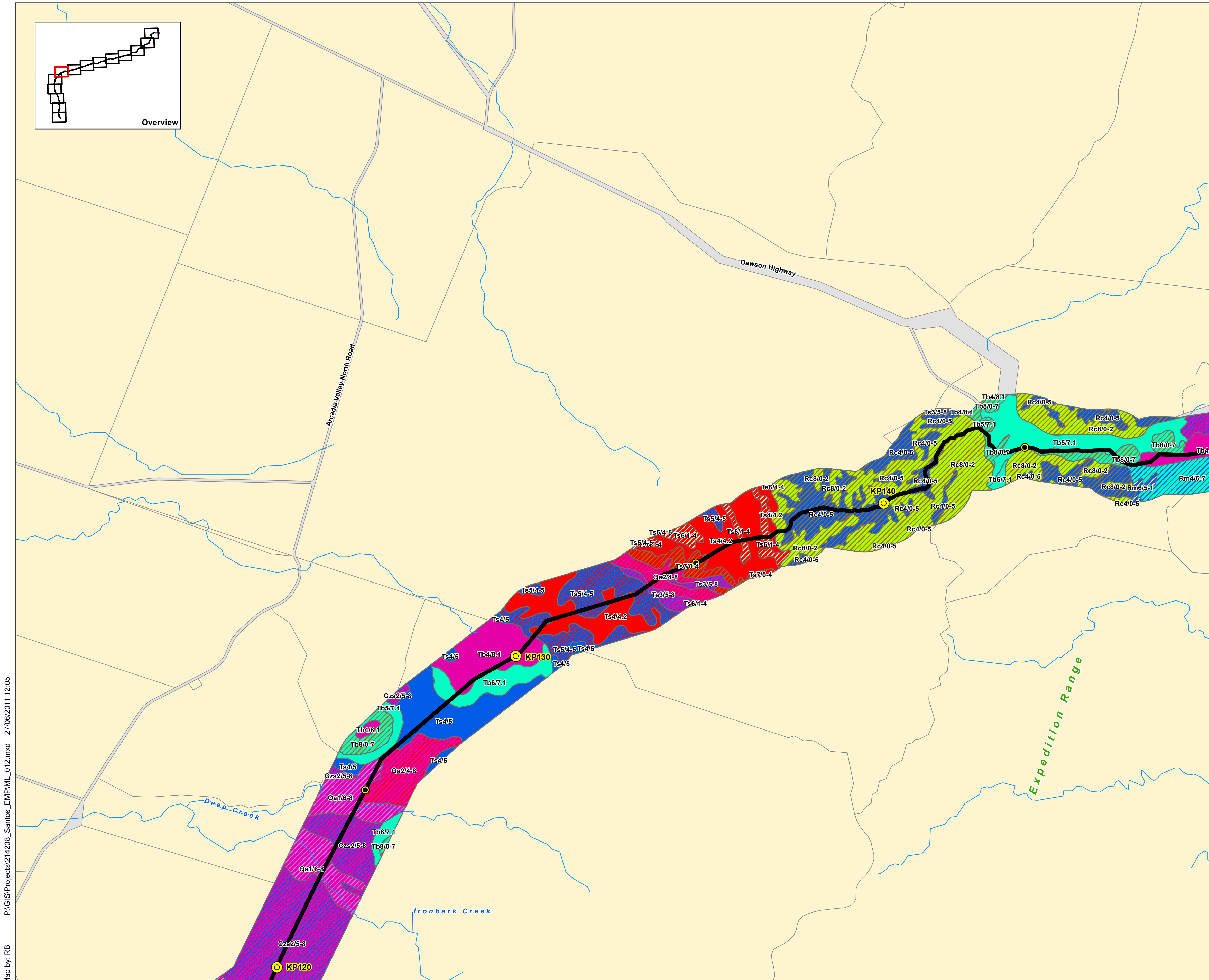
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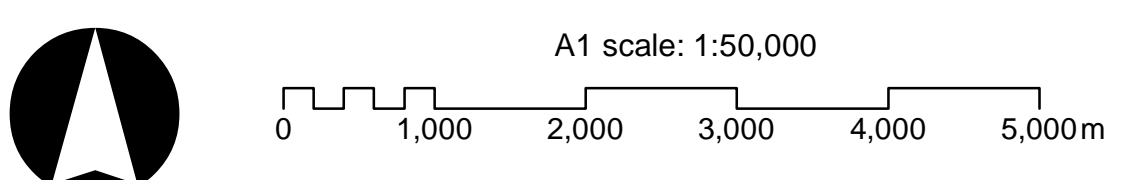
Soil Groups Figure 7.3 (Page 6 of 14)

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GLNG No: 3381-40-0407
 Coordinate system: GCS_GDA_1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

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Kilometre Post Distance Marker

- 10km
- 5km

Cadastre

- Rail
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Combined Soil Group

- | | | |
|-----|-----|-----|
| 0-2 | 2-6 | 5-6 |
| 0-4 | 2-7 | 5-7 |
| 0-5 | 2-8 | 5-8 |
| 0-7 | 3-7 | 6-7 |
| 1-4 | 4-5 | 6-8 |
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| 2-3 | 4-8 | |
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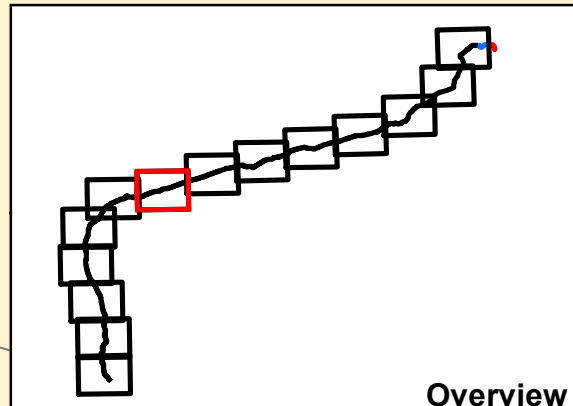
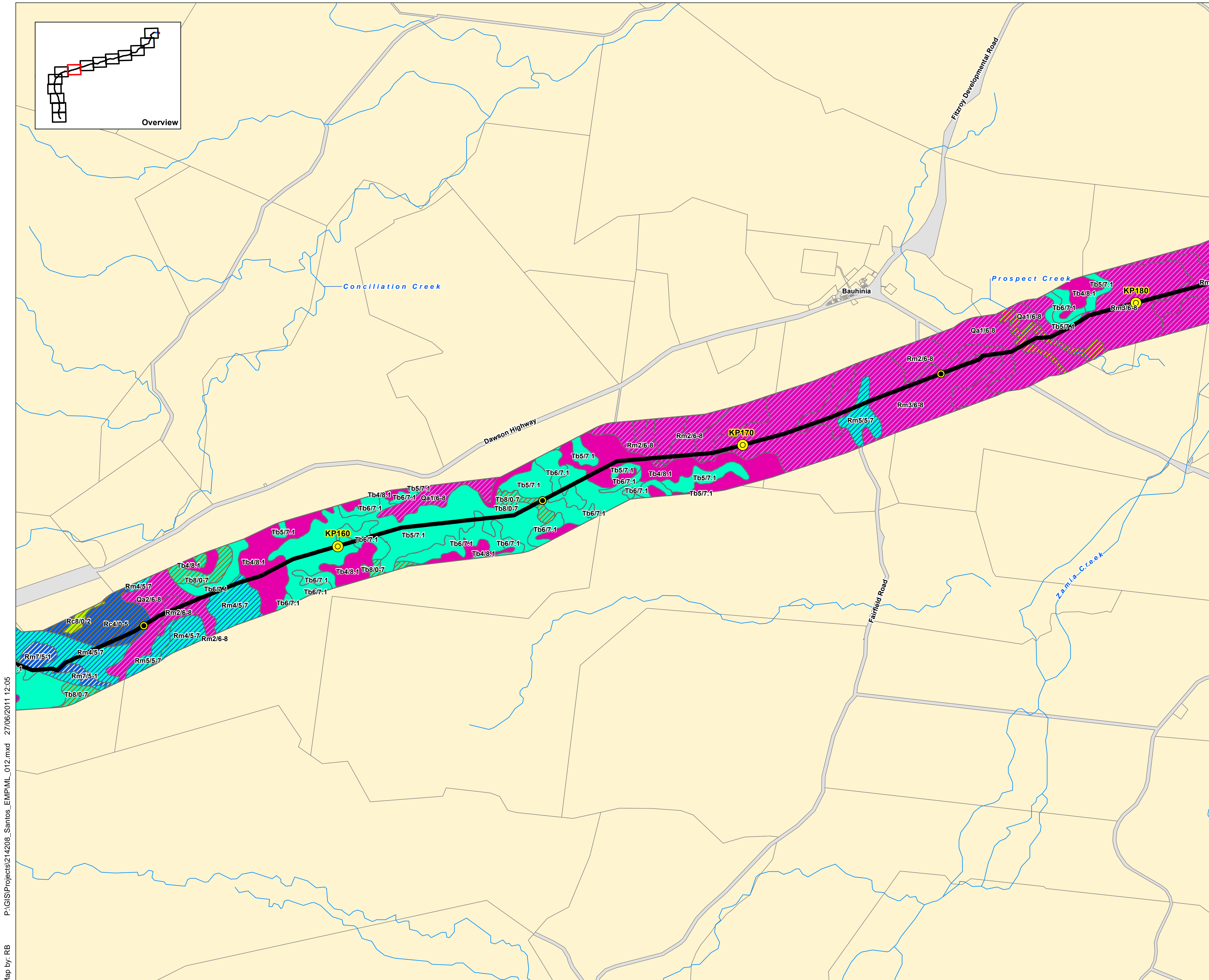
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 GLNG Terrain Units: Supplementary EIS, URS, 2009.

Soil Groups
Figure 7.3 (Page 7 of 14)

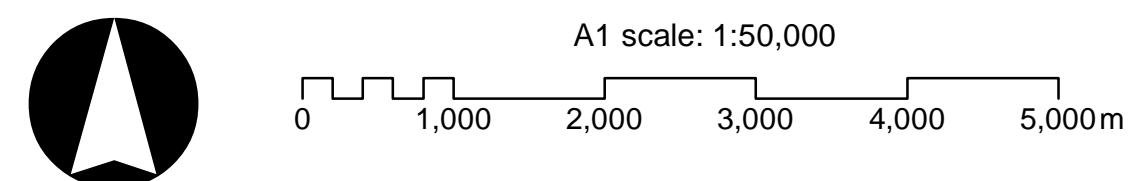
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Mainland GTP EM Plan

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Cadastre

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- 7 - Shallow and deep uniform fine-textured (non-cracking) clay soils
- 8 - Shallow and deep uniform fine-textured (cracking) clay soils
- 9 - Tidal area soils
- Water

Combined Soil Group

- | | | |
|-----|-----|-----|
| 0-2 | 2-6 | 5-6 |
| 0-4 | 2-7 | 5-7 |
| 0-5 | 2-8 | 5-8 |
| 0-7 | 3-7 | 6-7 |
| 1-4 | 4-5 | 6-8 |
| 1-5 | 4-6 | 7-8 |
| 1-6 | 4-7 | 7-9 |
| 2-3 | 4-8 | |
| 2-5 | 5-1 | |

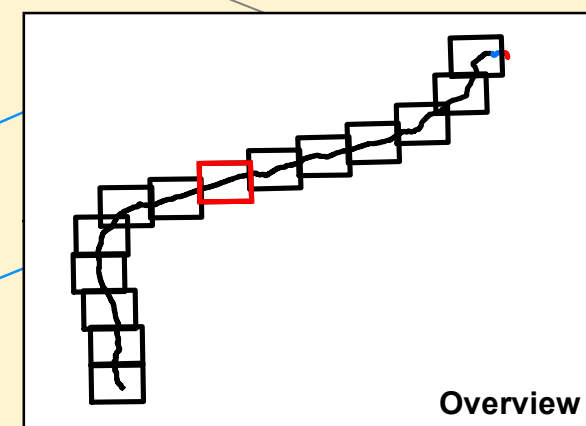
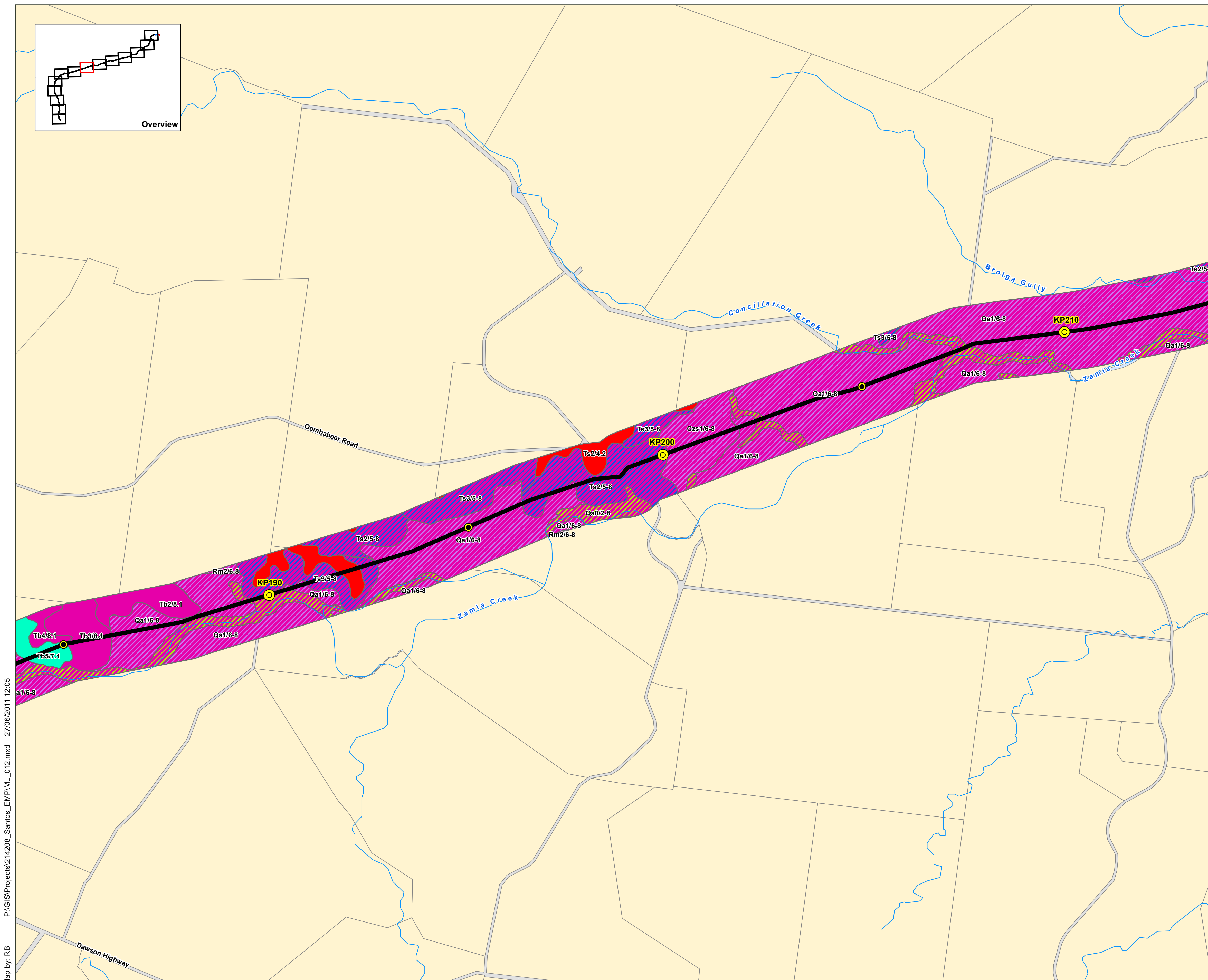
Note: All figures should be reviewed in conjunction with Table 7.1 "Generic Key to the Identification of Terrain Units", URS 2009.

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Cadastre: Department of Management and Resource Management, Jun 2011.
GLNG Terrain Units: Supplementary EIS, URS, 2009.

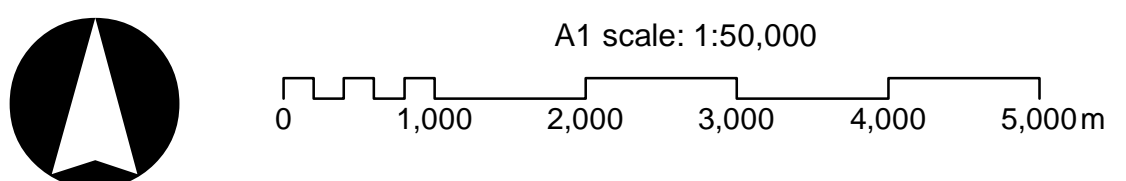
Soil Groups Figure 7.3 (Page 8 of 14)

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Map by: RB



GLNG No: 3381-40-0407
Coordinate system: GCS_GDA_1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 10km
- 5km

Cadastre

Rail

Watercourse

Soil Group

- 0 - Rocky outcrops and skeletal soils
- 1 - Shallow stony, gravelly and rocky soils
- 2 - Uniform or weakly gradational coarse-textured sandy soils
- 3 - Coarse to medium-textured, uniform or gradational sandy soils
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- Water

Combined Soil Group

- | | | |
|-----|-----|-----|
| 0-2 | 2-6 | 5-6 |
| 0-4 | 2-7 | 5-7 |
| 0-5 | 2-8 | 5-8 |
| 0-7 | 3-7 | 6-7 |
| 1-4 | 4-5 | 6-8 |
| 1-5 | 4-6 | 7-8 |
| 1-6 | 4-7 | 7-9 |
| 2-3 | 4-8 | |
| 2-5 | 5-1 | |

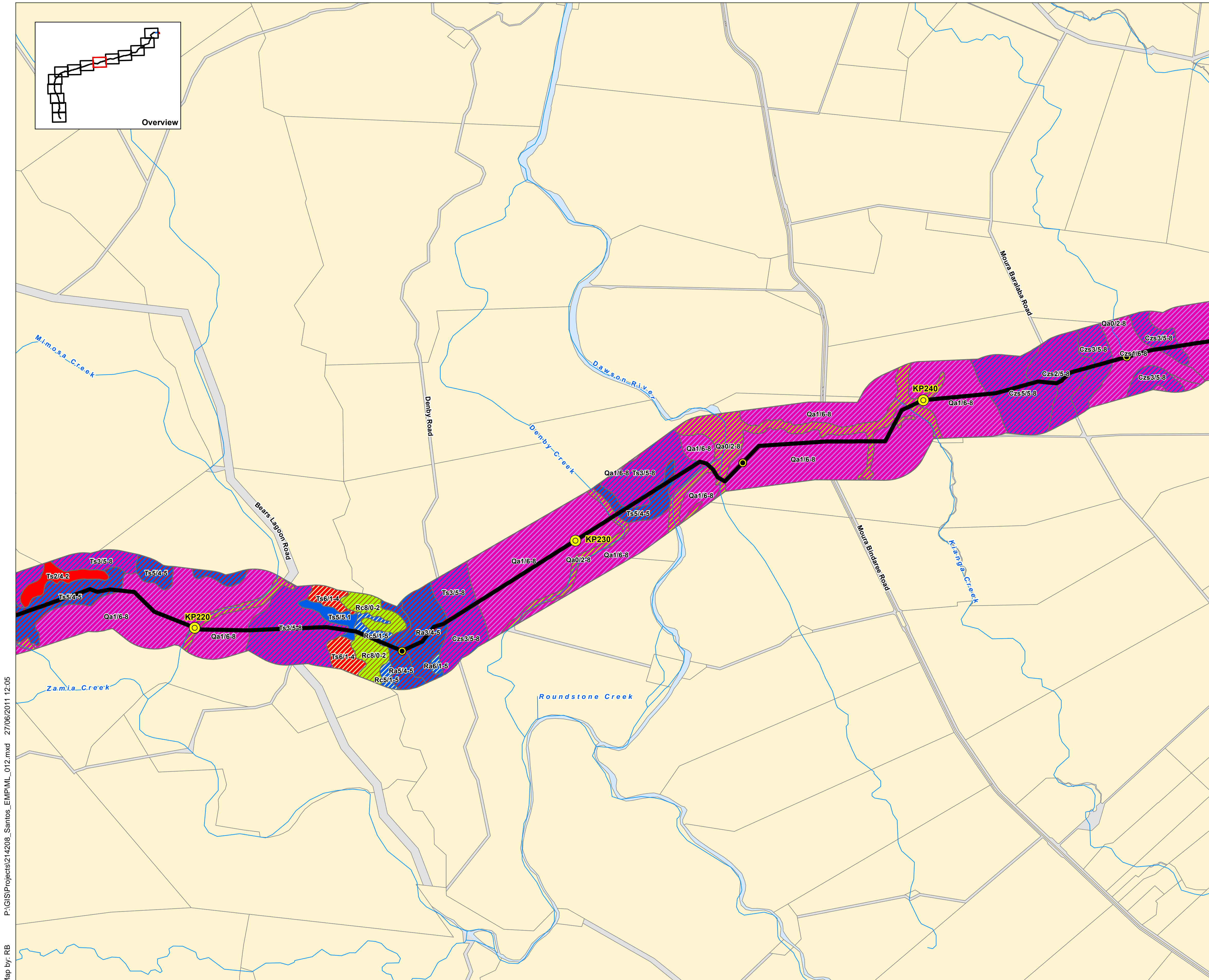
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Cadastre: Department of Management and Resource Management, Jun 2011.
GLNG Terrain Units: Supplementary EIS, URS, 2009.

Soil Groups Figure 7.3 (Page 9 of 14)

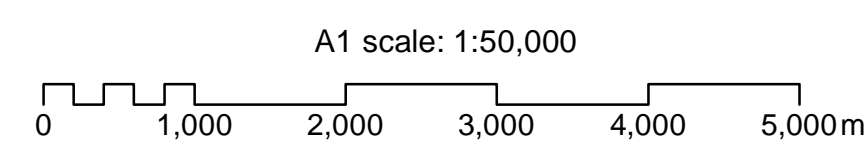
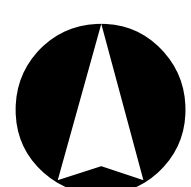
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Map by: RB



GLNG No: 3381-40-0407
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Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 10km
- 5km

Cadastre

- Rail
- Watercourse

Soil Group

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- 8 - Shallow and deep uniform fine-textured (cracking) clay soils
- 9 - Tidal area soils
- Water

Combined Soil Group

- | | | |
|-----|-----|-----|
| 0-2 | 2-6 | 5-6 |
| 0-4 | 2-7 | 5-7 |
| 0-5 | 2-8 | 5-8 |
| 0-7 | 3-7 | 6-7 |
| 1-4 | 4-5 | 6-8 |
| 1-5 | 4-6 | 7-8 |
| 1-6 | 4-7 | 7-9 |
| 2-3 | 4-8 | |
| 2-5 | 5-1 | |

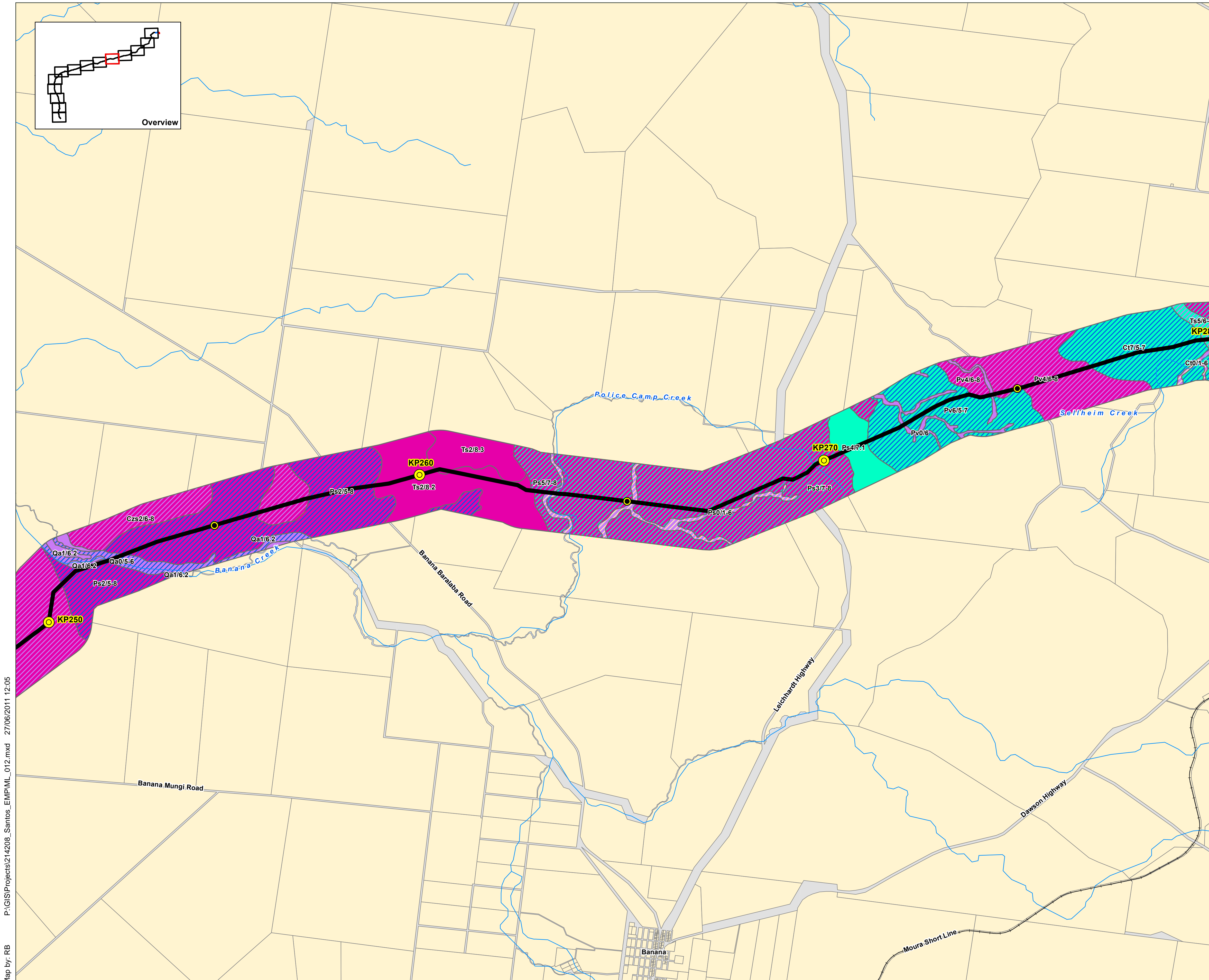
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Soil Groups
Figure 7.3 (Page 10 of 14)

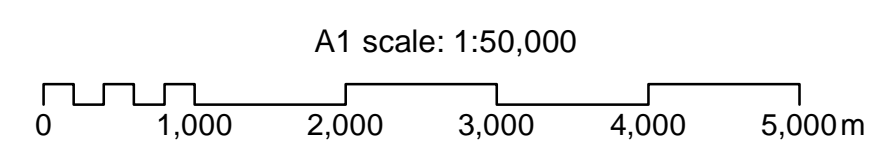
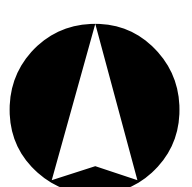
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Map by: RB



GLNG No: 3381-40-0407
 Coordinate system: GCS_GDA_1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 10km
- 5km

Cadastre

- Rail
- Watercourse

Soil Group

- 0 - Rocky outcrops and skeletal soils
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- Water

Combined Soil Group

- | | | |
|-----|-----|-----|
| 0-2 | 2-6 | 5-6 |
| 0-4 | 2-7 | 5-7 |
| 0-5 | 2-8 | 5-8 |
| 0-7 | 3-7 | 6-7 |
| 1-4 | 4-5 | 6-8 |
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| 1-6 | 4-7 | 7-9 |
| 2-3 | 4-8 | |
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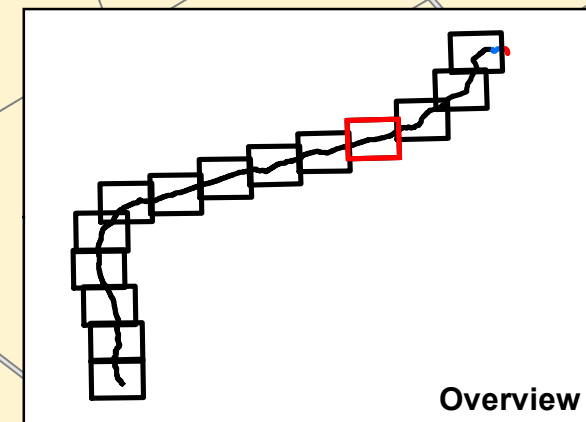
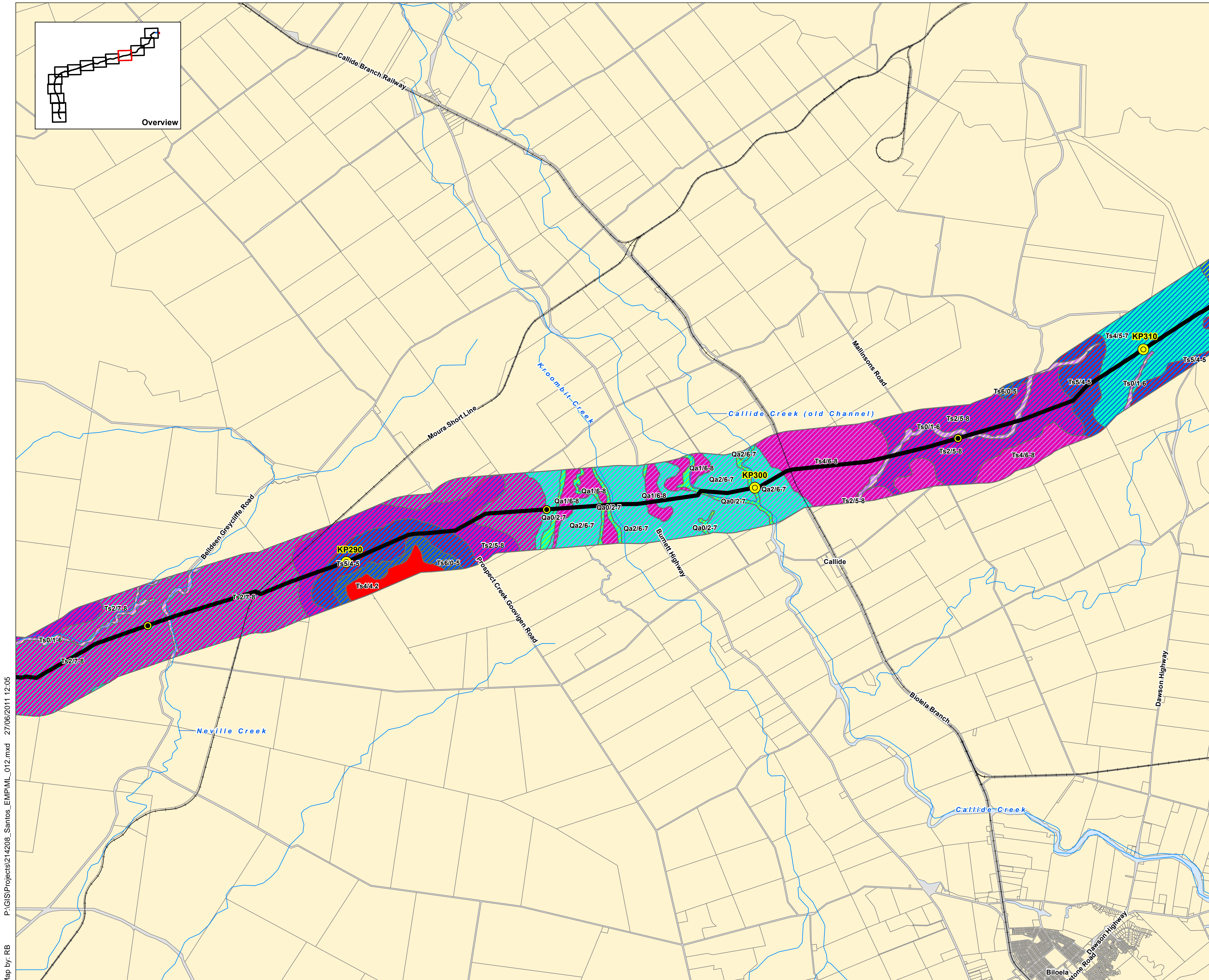
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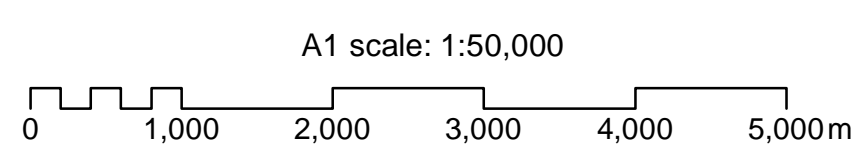
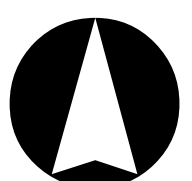
Soil Groups Figure 7.3 (Page 11 of 14)

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Map by: RB



GLNG No: 3381-40-0407
Coordinate system: GCS_GDA_1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

10km

5km

Cadastre

Rail

Watercourse

Soil Group

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- 9 - Tidal area soils
- Water

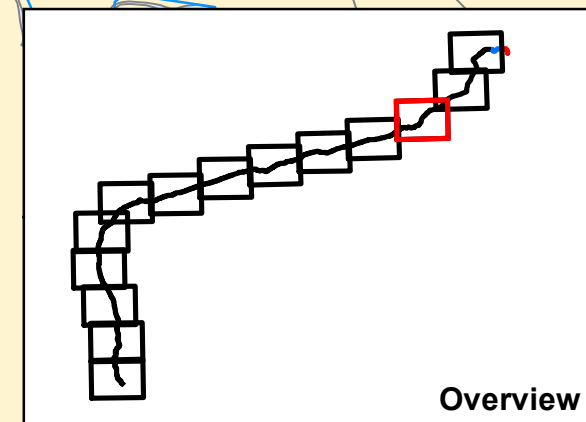
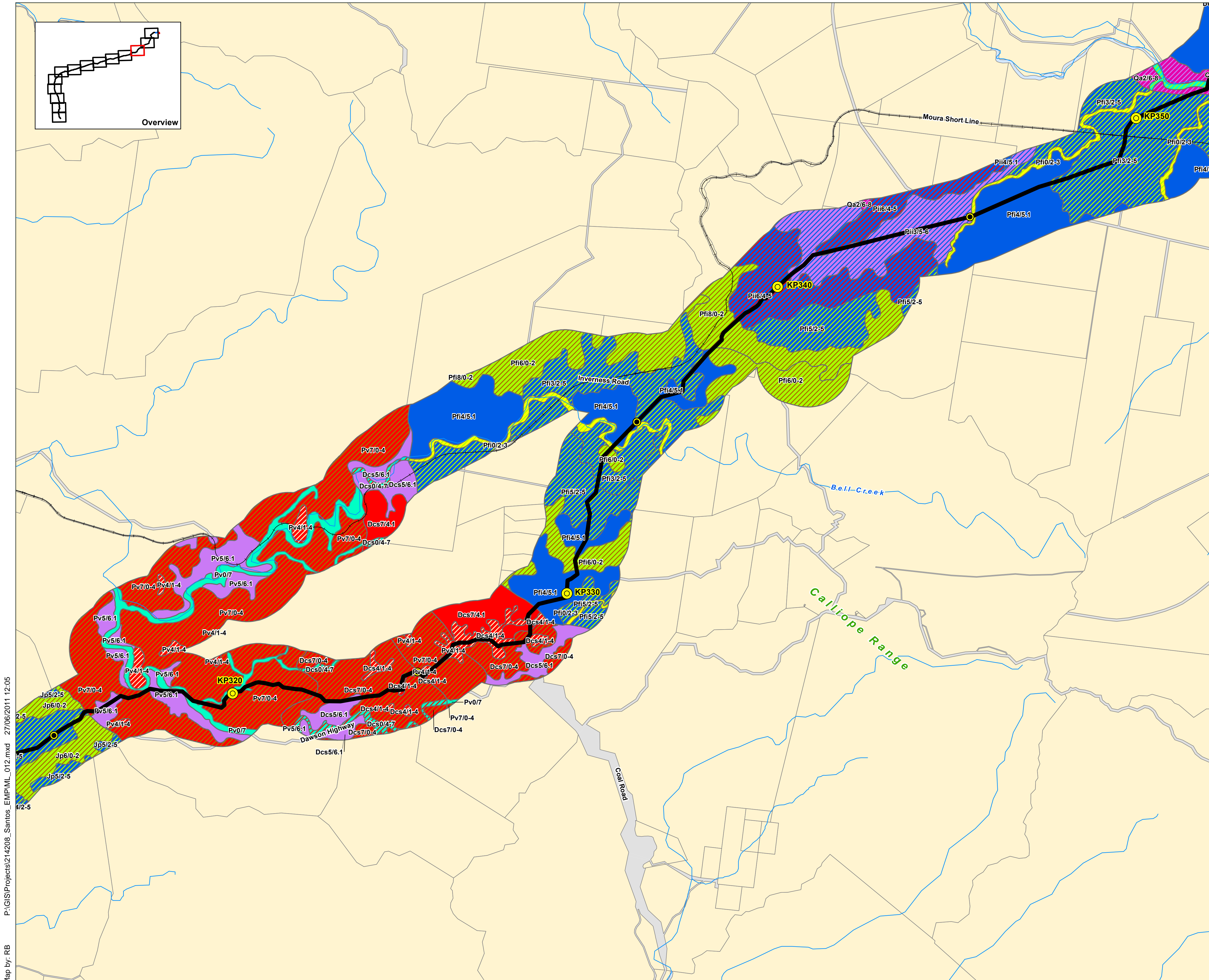
Combined Soil Group

- | | | |
|-----|-----|-----|
| 0-2 | 2-6 | 5-6 |
| 0-4 | 2-7 | 5-7 |
| 0-5 | 2-8 | 5-8 |
| 0-7 | 3-7 | 6-7 |
| 1-4 | 4-5 | 6-8 |
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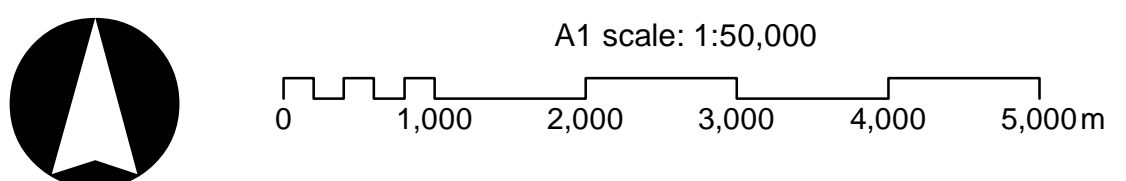
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GLNG Terrain Units: Supplementary EIS, URS, 2009.

Soil Groups Figure 7.3 (Page 12 of 14)



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Map by: RB



GLNG No: 3381-40-0407
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Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

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- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 10km
- 5km

Cadastre

- Rail
- Watercourse

Soil Group

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Combined Soil Group

- | | | |
|-----|-----|-----|
| 0-2 | 2-6 | 5-6 |
| 0-4 | 2-7 | 5-7 |
| 0-5 | 2-8 | 5-8 |
| 0-7 | 3-7 | 6-7 |
| 1-4 | 4-5 | 6-8 |
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| 2-5 | 5-1 | |

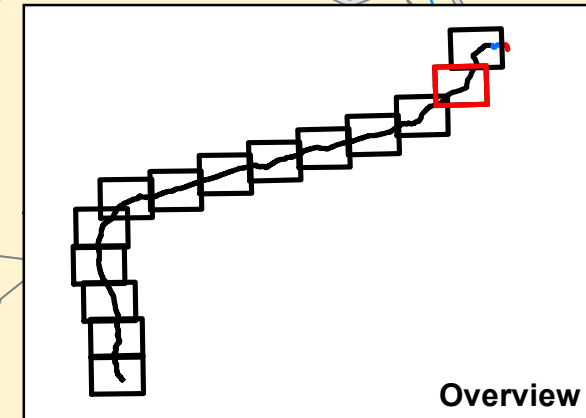
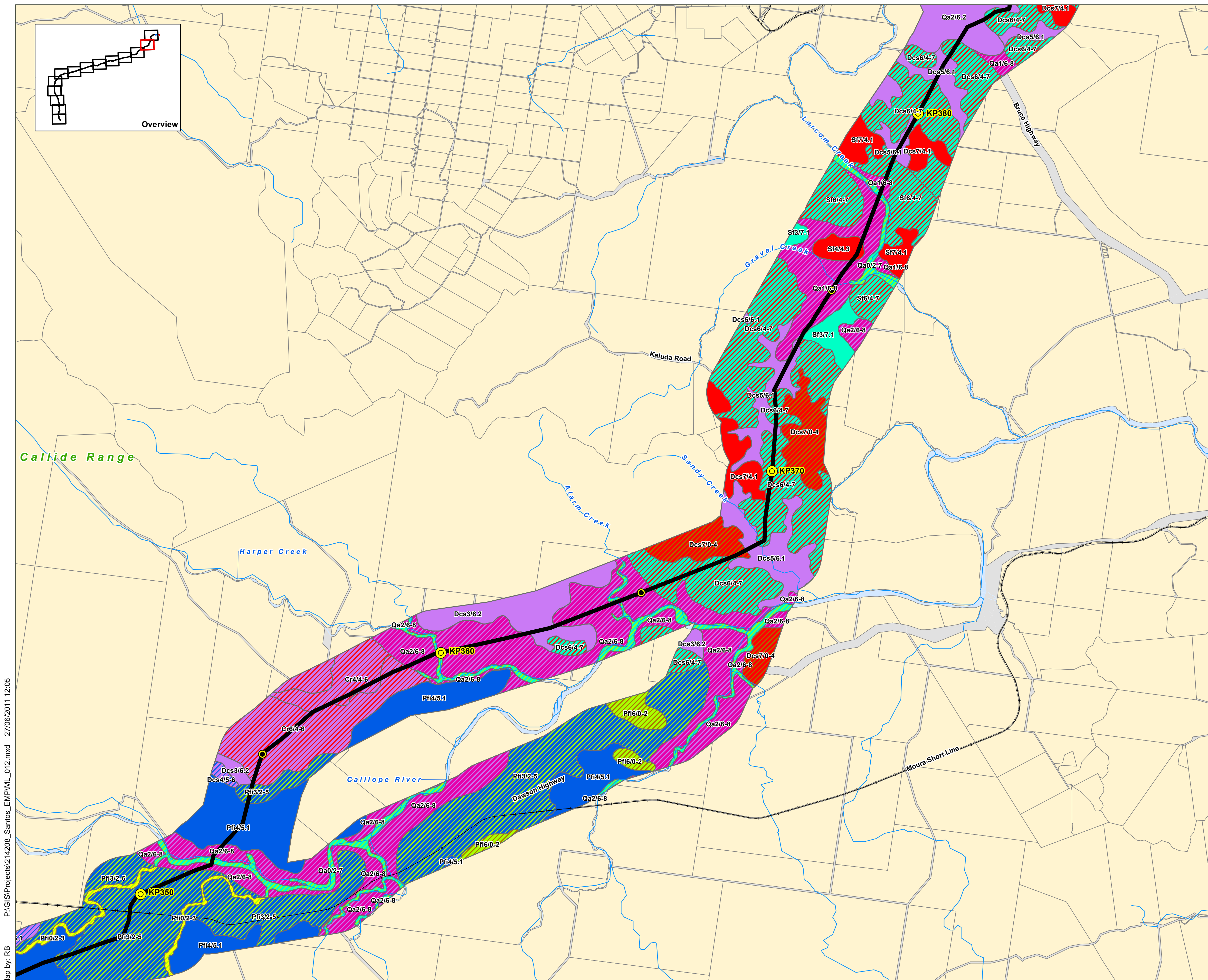
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Soil Groups
Figure 7.3 (Page 13 of 14)

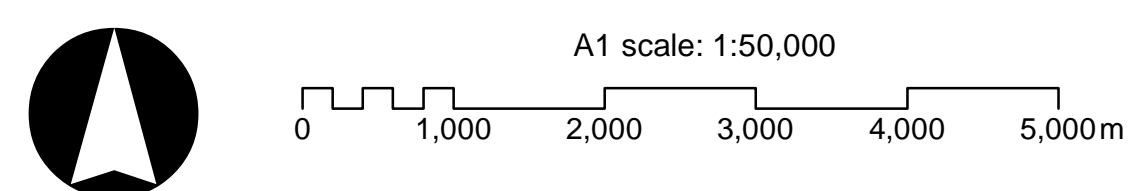
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Map by: RB



GLNG No: 3381-40-0407
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Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
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Kilometre Post Distance Marker

- 10km
- 5km

Cadastre

- Rail
- Watercourse

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Combined Soil Group

- | | | |
|-----|-----|-----|
| 0-2 | 2-6 | 5-6 |
| 0-4 | 2-7 | 5-7 |
| 0-5 | 2-8 | 5-8 |
| 0-7 | 3-7 | 6-7 |
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| 1-5 | 4-6 | 7-8 |
| 1-6 | 4-7 | 7-9 |
| 2-3 | 4-8 | |
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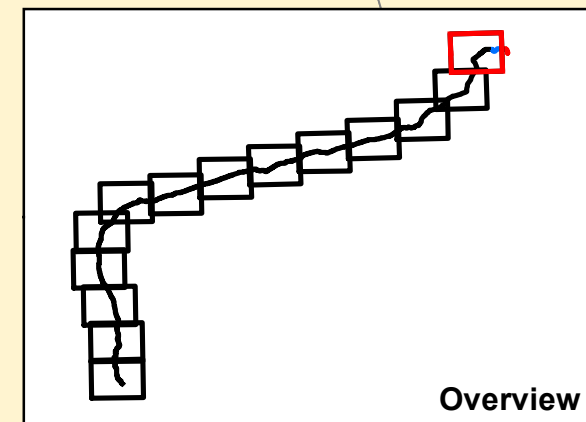
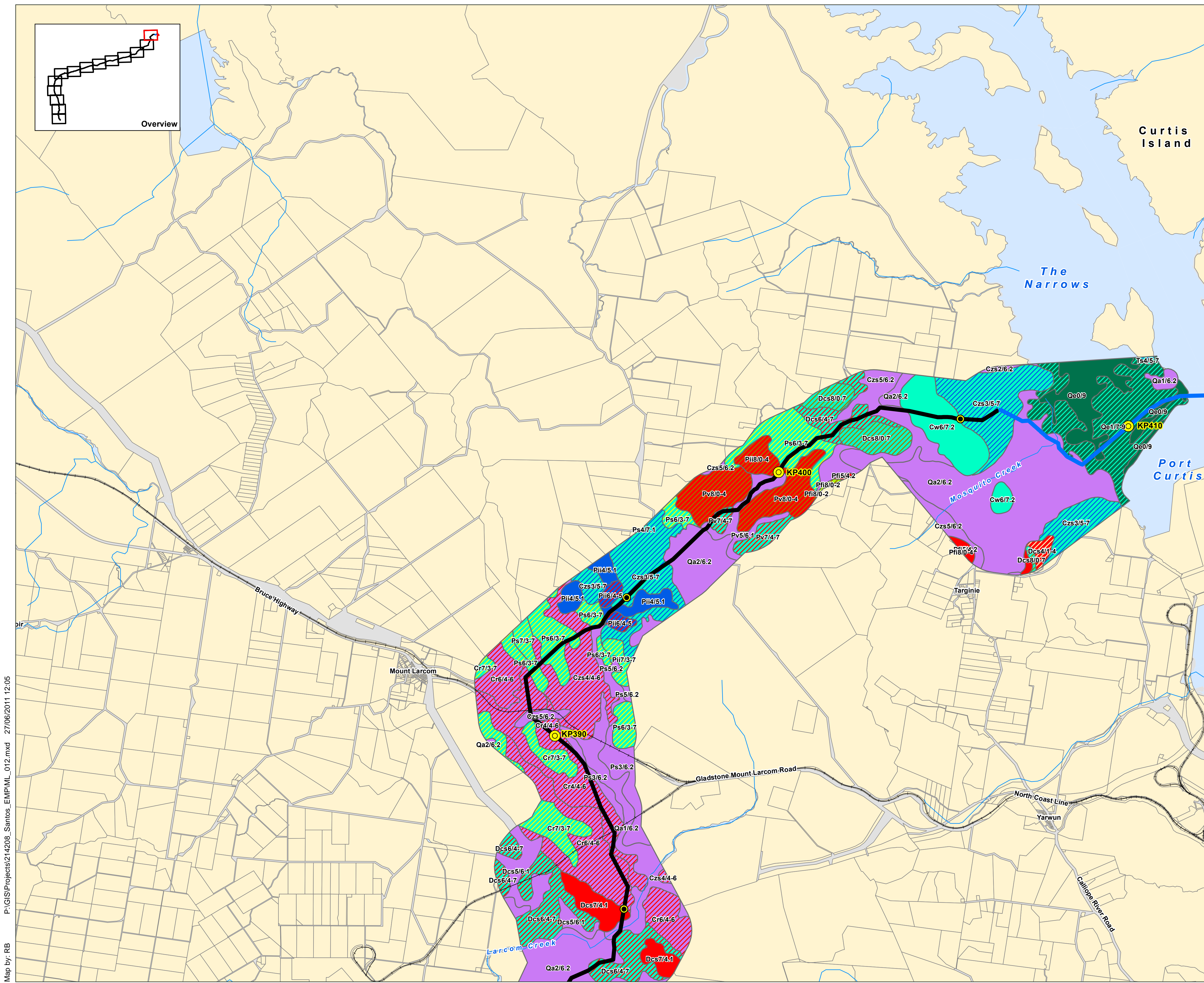
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Soil Groups Figure 7.3 (Page 14 of 14)

Date: 27/06/2011

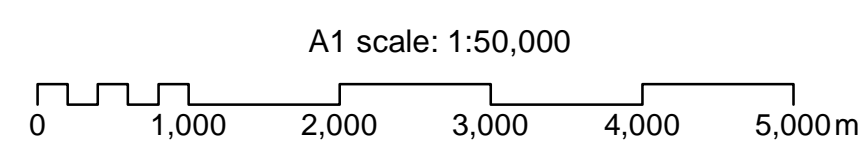
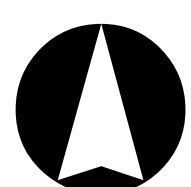
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Overview

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Map by: RB



GLNG No: 3381-40-0407
Coordinate system: GCS_GDA_1994

An example of Soil Type 2.1 was encountered at KP 216 during the geotechnical investigations (MLTP216) undertaken by Coffey Geotechnics (2009), near Zamia Creek. A photograph showing the testpit of this profile is presented in Photograph 1 below. The soil profile was shallow, with the excavator reaching refusal on moderately weathered sandstone at 0.4 m depth.



Photograph 7.1 Soil Type 2.1 encountered at KP 216 (MLTP216) (Coffey Geotechnics 2008)

Soil Type 2.2 - These soils comprise mainly of alluvial, in places stratified, alluvial or colluvial deposits comprising medium deep (>0.5 m) uniform, slightly acidic brown single-grain loose sandy soils. These soils are classified as Stratic Rudosols (ASC Isbell 1996).

Soil Type 2.3 - These soils occur mainly on the mid to lower slopes in hilly sandstone lands and comprise medium to deep (0.5->1.0 m) sands and loamy sandy soils with organic humic surface soils over red-brown or yellowish red, slightly to moderately acidic sandy subsoils underlain by weathered rock. These soils may be classified as Leptic Rudosols (ASC Isbell 1996).

Soil Group 3 - Coarse to medium-textured, uniform or gradational sandy soils

Group 3 soils comprise coarse to medium-textured, uniform or gradational predominantly sandy earth soil profiles. As mapped, these soil types predominately occur east of the Calliope Range and occur in association with soil Group 2 and soil Group 7. Two soil type variants of this group have been identified as occurring in the Mainland GTP RoW. These include:

Soil Type 3.1 - These soils occur on upper slopes and crests in hilly lands and comprise shallow uniform or weakly gradational bleached massive earthy sands and ferruginous gravelly sandy loam soils with neutral to acidic subsoils transitional to the weathered rock substrate. These soils are classified as Bleached Orthic Tenosols (ASC Isbell 1996).

Soil Type 3.2 - As mapped, these soils occur on banks and levees along alluvial drainage lines and comprise medium to deep (0.5->1.0 m) gradational massive earthy sand soils with neutral to slightly acidic brown sandy light clay or clayey sand subsoils. These soils are classified as Stratic Rudosol-Tenosol (ASC Isbell 1996).

Soil Group 4 - Medium-textured gravelly uniform or gradational loam to clay loam soils

Group 4 soils include medium-textured frequently stony or gravelly uniform or gradational loam to clay loam soil profiles with massive to weakly to moderately structured clay loam, light clay or medium clay subsoils. These soils are common along the Mainland GTP RoW. They have been mapped as occurring in association with soil groups 5, 6, 7 and 8. Three soil type variants have been identified as occurring within the Mainland GTP RoW. These include:

Soil Type 4.1 - These soils occur on the higher parts of strongly undulating to low hilly lands and on the crestal areas and upper marginal slopes of hilly and high hilly lands where they comprise mainly shallow (<0.5 m) stony and/or ferruginous gravelly uniform or weakly gradational brownish black, brown, red-brown or red massive loams and clay loam soil profiles underlain by weathered rock. These soils are classified as Leptic Rudosols or Red-Brown Kandosols (ASC Isbell 1996).

Soil Type 4.2 - As mapped these soils occur on the mid slopes of low rises in strongly undulating plains underlain by Permian sediments. They comprise medium to deep (0.5->1.0 m) gradational loamy surface red earth soils with clay loam to light clayey subsoils often with lateritic gravel included. These soils are classified as Red Kandosols or Ferric Red Kandosols (ASC Isbell 1996).

Soil Type 4.3 - As mapped these soils occur on low rises and on levees and alluvial terraces in the upper parts of narrow valley floors. They comprise medium to deep (0.5->1.0 m) gradational sandy loam to loamy surface soils over red and brown weak to moderately well-structured neutral to moderately alkaline clay loam to light clayey subsoils. These soils are classified as Red Kandosols (ASC Isbell 1996).

Only very limited analytical data is available for these Group 4 soils; however calcium and magnesium are reported by R. H. Gunn – CSIRO (1967) to be the dominant cations. The cation exchange capacity (CEC) is low (<8 m-equiv./100g soil), plant available water capacity (PAWC) is low. Soil salinity levels are low and indicative testing of the fines content of the soils indicates non dispersive to very low dispersion characteristics.

Soil Group 5 – Sandy or loamy duplex profiles with clay subsoils

Group 5 soils comprise sand, loamy sand and loamy surface duplex soils with mostly acidic to neutral or slightly alkaline sandy clay to medium to heavy clay subsoils. These soil types occur in association with soil Group 1, 6, 7, and 8. Soil Group 5 soils are commonly found in hilly or lands near the ranges. Three soil type variants have been identified as occurring within the Mainland GTP RoW area. These include:

Soil Type 5.1 - These soils occur mainly in hilly lands underlain by sandstone bedrock and in particular on the eroded margins of dissected sandstone plateau areas. They comprise shallow (<0.5 m) sandy, sandy loam or loamy surface duplex soils with yellow-brown, grey-brown or red-brown often gravelly, weak to moderately strongly structured acidic to neutral, in parts strongly acidic sandy clay or medium to heavy clay subsoils with hard dry consistence. These soils are classified as Red-Brown Chromosols or Red-Brown Kurosols (ASC Isbell 1996).

Soil Type 5.2 - These soils occur in undulating and gently to moderately sloping lands underlain by sandstone bedrock and in parts by intrusive (granitic) bedrock. They comprise medium to deep (0.5->1.0 m) duplex soils with thick (>0.3 m) sand or loamy sand surface (A) horizon, often with a pale or bleached sub-surface (A2) horizon with an abrupt change to yellowish-brown, grey-brown or reddish-brown, locally prominently mottled sandy clay to medium clay subsoils. The subsoils are poorly drained, mostly moderately to strongly acidic with massive tending to coarse blocky or columnar structure with depth. These soils are classified as Red-Yellow-Brown Chromosols or Sodic Kurosols (ASC Isbell 1996).

Soil Type 5.3 - These soils occur on slopes of up to 5% and are similar to Soil Type 5.2 except that they have thinner (<0.3 m) sandy, sandy loam or loamy surface soils that tend to be hard-setting, usually with a pale or bleached (A2) sub-surface horizon underlain by brown or yellowish brown sandy clay or medium clay neutral to moderately acidic hard, medium to coarse blocky structured subsoils. These soils are classified as Red-Brown Chromosols or Red-Brown Sodosols (ASC Isbell 1996).

Soil type 5.3 was encountered during the geotechnical investigations at KP 157.75 (MLTP079). A photograph of the exposed soil profile in the test pit is presented in Photograph 2 below. This profile was mapped in the terrain units as occurring on Rm4/5-7, however it was in close proximity to the mapped boundary of terrain units Tb4/8.1 and Tb8/0-7. Analytic data was not available for this profile.



Photograph 1 Soil Type 5.3 encountered at KP 157.75 (MLTP079) (Coffey Geotechnics 2008)

Analytical data available for these soils is limited. Data reported by R. H. Gunn (CSIRO, 1967) indicates these soils are acidic in the surface soil horizons, tending to neutral in the deeper subsoils. Cation exchange capacity (CEC) is low in the surface soils (<5 m-equiv./100 g soil) and <20 m-equiv./100 g soil in the subsoil horizons. Magnesium is the dominant metal cation throughout the profile. Total soluble salts and salinity levels were low in the surface soils but tend to increase to moderate levels in the deeper subsoils. The less gravelly (more clayey) soil variants tend to be non-sodic to slightly sodic in the surficial soil layers, becoming strongly sodic in the subsoils below a depth of approximately 0.6 m. The high levels of sodium and magnesium indicate a potential for soil structural instability and for dispersion of the deeper clay materials. Total nitrogen and available phosphorus are mostly deficient in the surface soil horizons.

Soil Group 6 – Loamy or clayey duplex profiles with medium to heavy clay subsoils

Group 6 soils comprise mostly thin fine sandy loam, silt loam or clay loamy surface duplex soils with neutral to alkaline, often strongly alkaline, usually with carbonate present in the medium to heavy clay or heavy clay subsoils. Associations between soil group 6 and soil group 8 are wide spread in the undulating plains of the alignment Mainland GTP RoW, including the Arcadia Valley and East of Dawson Highway to the Callide Range. Two soil type variants were identified as occurring within the Mainland GTP RoW area. These include:

Soil Type 6.1 - These soils occur mainly on undulating plains, rolling rises and low hilly lands underlain by siltstone or mudstone bedrock. They comprise shallow (<0.5 m), gravelly, sandy or loamy surface duplex soils with yellow-brown, grey-brown or red-brown often gravelly, strongly alkaline sandy clay, light clay or medium to heavy clay subsoils with hard dry consistence and weak to moderate blocky to columnar soil structure. These soils are classified as Red-Yellow-Brown Calcic Mesonatric Sodosols (ASC Isbell 1996).

Soil Type 6.2 – These soils occur on gently to moderately inclined foot-slopes, on undulating plains and lowlands and on alluvial plains, stream terraces and floodplains associated with major streams and rivers, where they often occur in association with non-cracking clays and cracking clay soils of Group 7 and Group 8 respectively. The Type 6.2 soils comprise medium to deep (0.5->1.0 m) mainly hard-setting slightly acidic, fine sandy to silt loamy or clay loamy surface duplex soils in places with a pale or bleached subsurface (A2) horizon. There is a sharp transition to the subsoil (B) horizon which comprises brown, yellow-brown or red-brown alkaline to strongly alkaline medium to heavy clay subsoils which have moderate amounts of soft carbonate inclusions and weak to moderate blocky to columnar soil structure with hard dry consistence. The deeper subsoils tend to become more massive, apedal and strongly cohesive heavy clays with low to moderate levels of sodicity and salinity usually present. These soils may be classified as Red-Yellow-Brown Calcic Mesonatric Sodosols (ASC Isbell 1996).

Soil type 6.2 was encountered during the geotechnical investigations at KP 170.75 (MLTP095). A photograph of the exposed soil profile is presented in Photograph 3 below. This location was mapped in the terrain units as Rm3/6-8. The photograph shows the deep fine sandy grey soil overlying yellow clay subsoil. Limited laboratory analysis was undertaken on this profile, however, the Emerson Aggregate test gave a Class 2 for the subsoil (1.5 to 2.7 m). This indicates soil slakes with some dispersion, suggesting they are prone to erosion.



Photo 2 Soil Type 6.2 encountered at KP 170.75 (MLTP095) (Coffey Geotechnics 2008)

Reference to R. H. Gunn – CSIRO (1967) with respect to these soils, further indicates that calcium is the dominant metal cation in the surface soils whilst magnesium is dominant in the subsoils. Exchangeable sodium is high in the subsoils and the preponderance of sodium and magnesium accounts for the poor physical properties and dispersive characteristics of the subsoil layers.

Soil Group 7 - Shallow and deep uniform fine-textured (non-cracking) clay soils

As a group, these soils comprise shallow and deep uniform fine-textured (non-cracking) clay soils and gradational clay loam or light clayey surface soils with either acidic or alkaline, often sodic and in places saline medium to heavy clay or heavy clay subsoils. Locally, the soils tend to exhibit characteristics of (incipient) cracking clay soils. Three soil variants have been identified as occurring within the Mainland GTP RoW area. These include:

Soil Type 7.1 – These soil profiles occur mainly on low hilly, hilly and higher hilly lands where they have mainly developed on argillaceous sedimentary rock types and intermediate to basic volcanic rock lithologies. They comprise mainly shallow to medium deep (0.5 to 0.7 m) uniform light to medium acidic clays, or gradational clay loam, gravelly clay loam or gravelly clay surface soils with 30-50% fine gravel and coarse stone over gravelly acidic or alkaline dark brown, grey-brown clays or medium to heavy clay subsoils underlain by weathered rock generally below about 0.6 to 0.8 m. These soils are classified as Gravelly Grey-brown and Red-Brown Dermosols (ASC Isbell 1996).

Soil type 7.1 was encountered during the geotechnical investigations (test pit MLTP073) at KP 151.5. A photograph of the exposed soil profile is presented in Photograph 4 below. This location was mapped in the terrain units as Tb6/7.1. This profile was logged as highly plastic clay to 0.8 m, underlain by highly plastic, gravelly clay to 3.2 m. Analytical data indicates the clay subsoil (0.9 m) is alkaline and contains moderate salinity (0.62 dS/m). The Emerson Class is 4, indicating the soil slakes with no dispersion.



Photograph 3 Soil Type 7.1 encountered at KP 151.5 (MLTP073) (Coffey Geotechnics 2008)

Analytical data from two sites tested, indicated the clayey subsoils contain slightly to moderately sodic and dispersive soil layers. The ratio of calcium to magnesium in samples tested was very low, indicating potential soil structural stability problems.

Soil Type 7.2 – These soils occur mainly on undulating alluvial plains and on undulating lowlands and gently inclined slopes adjacent to and along drainage lines. They comprise medium to deep uniform clay soil profiles with light to medium clay texture throughout, or grade from clay loam at the surface to light to medium clay subsoils below about 0.3 to 0.5 m. The surface soils have granular structure becoming sub-angular blocky in the subsoils, tending to massive in the deeper subsoils. The surface soils are mostly dark brown and neutral to moderately acidic, with a gradual change to brown, yellowish or reddish-brown moderately to strongly alkaline clay subsoils. These soils are classified as Grey, Brown or Red Dermosols (ASC Isbell 1996).

Limited available analytical data from two sites indicated these soils tend to be slightly sodic and dispersive in the upper soil layers and strongly sodic and dispersive in the deeper subsoils. Soil salinity levels are low near the surface and in places become moderately high in the deeper subsoils.

Soil Type 7.3 – These soil profiles occur locally in association with soils of Group 5 on the lower footslopes in terrain unit Cw5/5-7. The soils comprise deep uniform clays or gradational brown to yellowish red silty clay or heavy clay surface soils. Subsoils can be diffusely mottled reddish-brown, brown or yellow-brown neutral to acidic and in places strongly acidic and sodic. Locally approaching the coast, subsoils can be moderately to highly saline in the medium to heavy or heavy clay subsoils. These soils may be classified as Acidic Sodic Mottled Grey, Brown and Red-brown Dermosols or Acidic Sodic Dermosolic Hydrosols (ASC Isbell 1996).

Indicative soil testing and analytical data from one site tested in terrain unit Qe2/7.3 during the EIS indicated that these soils are sodic and tend to become increasingly sodic to very high levels in the deeper heavy clay subsoils. However the samples tested from similar depths for dispersion class were non-dispersive, possibly related to the strong levels of acidity throughout the profile. Calcium/magnesium ratios were all very low and soil salinity levels were moderate increasing to high in the deeper medium to heavy clay subsoil layer.

Soil Group 8 - Shallow and deep uniform fine-textured (cracking) clay soils

In general, Group 8 soils include shallow, medium and deep to very deep uniform fine-textured (cracking) clay soils with dark grey, brown or black mostly alkaline medium to heavy clays throughout, or alkaline over acidic heavy clay subsoils in areas with intensive gilgai surface micro-relief. These soils are widely used for agricultural production. They occur in pockets throughout the study area, however, are commonly found in association with soil Group 6 in the western sections of the Mainland GTP RoW. The soils are strongly reactive and prone to substantial horizontal and vertical movement and associated cracking in the upper parts of the soil profile due to seasonal wetting and drying cycles.

Three soil type variants have been identified as occurring in the Mainland GTP RoW area. These include:

Soil Type 8.1 – These soils occur on slopes, mostly 2 to 3% up to 5% on gently undulating erosional plains and lowlands and undulating low plateau surfaces underlain by Tertiary volcanic rock types mainly basalt and on low rises underlain by argillaceous Permian sedimentary and volcanic rock types. They comprise shallow (<0.6 m) mainly uniform light to heavy clays formed in-situ. Surface soils when dry to just moist, have a friable, self-mulching granular structure becoming hard with medium to coarse angular blocky below (approximately 0.25 m). Soil reaction trend is neutral to slightly acidic near the surface and moderately to strongly alkaline in the subsoil where soft carbonate is usually present. Soil colour near the surface is dark grey or grey-brown, becoming lighter with depth approaching the underlying weathered rock zone. These soils are classified as Self-mulching Black or Brown Epicalcareous Vertosols (ASC Isbell 1996).

Soil Type 8.1 was encountered during the geotechnical investigations at MLTP080 (KP158.25). A photograph of this profile is provided in Photograph 5 below. The photograph shows a deeply cracking dark grey soil profile. This profile was logged as high plasticity clay to 4.0 m depth. This location was mapped in the terrain units as TB4/8.1.



Photograph 4 Soil Type 8.1 encountered at KP 158.25 (MLTP080) (Coffey Geotechnics 2008)

Soil Type 8.2 – These soils occur on rises and mid to upper slopes (2 to 5%) in gently to moderately undulating plains and lowlands formed on Triassic, Permian and some Tertiary mudstone, shale and calcareous sandstones. They comprise medium to deep (0.6->1.0 m) uniform sandy medium to heavy clays, colours are dark grey or grey-brown at the surface becoming gradually lighter with depth. Soil reaction at the surface is acidic to moderately alkaline and moderately to strongly alkaline in the deeper subsoils where soft carbonate is usually present. The surface soils generally have a thin crusty to weak granular friable self-mulching surface layer grading through hard coarse blocky structure in the subsoil tending to massive soil structure in the deeper subsoils (>0.6 to 0.8 m). These soils may be classified as Self-mulching Black or Brown Epicalcareous Vertosols (ASC Isbell 1996).

Soil Type 8.3 – These soils occur in the lower-lying older alluvial plains and river floodplain areas with near level to gently undulating relief. They are deep to very deep (typically >1.5 m), uniform medium to heavy clay soils typically with strongly developed gilgai micro-relief with vertical intervals between gilgai mounds and troughs ranging from 0.3 to 1.0 m. Surface soils are dark grey-brown, dark grey or brown, which generally become lighter in colour with depth. Black manganiferous staining is common below a depth of 1.0 m and prominent coarse red, yellow or brown mottling occurs in the deeper subsoils. When dry, there is usually a thin surface crust present on the gilgai mounds, underlain by hard coarse blocky structured subsoils. Large cracks form in the gilgai depressions and there is usually a thin self-mulching granular surface layer present. Soil reaction is variable but frequently moderately to strongly alkaline near the surface, with soft carbonate present in the subsoil layer, becoming acidic to strongly acidic in the deeper subsoil layers. Surface and internal profile drainage is poor and water may be retained in the gilgai depressions for lengthy periods.

Analytical data on these soils from R. H. Gunn – CSIRO (1967), indicates salinity levels are low in the surficial (0.3 m) soil layers, becoming high in the lower subsoils. Soil sodicity Exchangeable Sodium Percentage (ESP) levels are <10% in the surficial soils but become high (15 to 25%) in the subsoils and extremely high (>25%) in the deeper subsoils. Calcium is the dominant metal cation in the surface soil layers, with magnesium becoming dominant in the deeper subsoils indicating potential soil structural instability and dispersion in the deeper subsoil layers. Nitrogen, phosphorus and potassium levels are variable but generally at moderately high levels and clay mineral determinations indicate that montmorillonite and kaolinite are the co-dominant clay minerals.

The distribution of Soil Groups along the Mainland GTP RoW area is presented in Figure 7.3.

7.3.4 Terrain Unit Distribution along Mainland GTP

The distribution of geology, landform and soil groups as terrain units along the Mainland GTP RoW is presented in conjunction with the Soil Groups Figure (Figure 7.3). Note that information on terrain units should be read in conjunction with Table 7.1 “*Generic Key to the identification of Terrain Units*”, URS 2009. This key represents all possible combinations of geological regime, landform-terrain type and soils that occur along the GTP from Fairview to Curtis Island. Not all of these combinations are present in the Mainland GTP RoW and are therefore not discussed in this report.



Table 7.1 Generic Key to the Identification of Terrain Units

Generic Key to the Identification of Terrain Units

GEOLOGICAL REGIME		LANDFORM – TERRAIN TYPE			SOILS	
Symbol	Description	Type	Surface Form and Slope	Group	Soil Types ⁽¹⁾	
Qe	Quaternary (Holocene) Estuarine Sediments	0	Channel floors, banks and active levees of major streams and waterways with irregular steep, and locally benched bank slopes and low flood terraces. Locally tidal mangrove and marine flats and tidal inlets with mangroves fringing.	0	Extensive areas of rock outcrop, locally with skeletal to shallow usually stony or gravelly soils.	
Qa	Quaternary Alluvium				Skeletal, rocky or gravelly soils (>60% coarse fragments) with sandy, silty, loamy or clayey soil matrix (K- Uc1, Um1, Gn1, Uf1).	
Czs	Cainozoic Sediments	1	Floodplains, alluvial flats, lower stream terraces and flat to broadly depressional backplains, slopes typically <1%; periodically floodprone and locally poorly drained areas. Locally comprising estuarine/marine plains, extratidal and supratidal flats subject to periodic tidal inundation; slopes mostly <0.5%.	1	Skeletal, rocky or gravelly soils (>60% coarse fragments) with sandy, silty, loamy or clayey soil matrix (K- Uc1, Um1, Gn1, Uf1).	
Ts	Tertiary Sediments				Sand soils; shallow to deep uniform or weakly gradational profiles; includes stratified alluvial soils, residual sand soils, earthy sands (Uc1-Uc6) ⁽²⁾ ; Rudosols or Tenosol Soil Orders. ⁽³⁾	
Tb	Tertiary Volcanic Rocks mostly basalt	2	Flat to gently undulating or gently inclined intermediate to higher stream terraces, older alluvial plains or, floodplains and higher stream terraces, with slopes generally <2%; occasionally floodprone in lower-lying areas and along tributary drainage channels.	2	Sand soils; shallow to deep uniform or weakly gradational profiles; includes stratified alluvial soils, residual sand soils, earthy sands (Uc1-Uc6) ⁽²⁾ ; Rudosols or Tenosol Soil Orders. ⁽³⁾	
Jp	Jurassic Precipice Sandstone				Sand soils; shallow to deep uniform or weakly gradational profiles; includes stratified alluvial soils, residual sand soils, earthy sands (Uc1-Uc6) ⁽²⁾ ; Rudosols or Tenosol Soil Orders. ⁽³⁾	
Je	Early-Middle Jurassic Evergreen Formation	2	Flat to gently undulating or gently inclined intermediate to higher stream terraces, older alluvial plains or, floodplains and higher stream terraces, with slopes generally <2%; occasionally floodprone in lower-lying areas and along tributary drainage channels.	3	Coarse to medium-textured soils; uniform or gradational profiles; predominantly sandy earths, silty or clayey sand profiles (Uc4-5, Um1-3); Tenosols or Podsol Soil Orders.	
Jh	Early Jurassic Hutton Sandstone				Coarse to medium-textured soils; uniform or gradational profiles; predominantly sandy earths, silty or clayey sand profiles (Uc4-5, Um1-3); Tenosols or Podsol Soil Orders.	
Rc	Early-Middle Triassic Clematis Group	3	Undulating plain and gently rolling to broadly rounded rises with gently inclined planar to concave intervening lower-lying broadly depressional areas; slopes mostly in the range 1-3%.	4	Medium-textured sandy, sandy loam or silt to clay loamy surface uniform or gradational profiles, often (siliceous or ferruginous) gravelly or stony soils; (Um4-7, Gn1-2); Tenosols, Kandosols or Ferrosol Soil Orders.	
Rm	Triassic Moolayember Formation				Medium-textured sandy, sandy loam or silt to clay loamy surface uniform or gradational profiles, often (siliceous or ferruginous) gravelly or stony soils; (Um4-7, Gn1-2); Tenosols, Kandosols or Ferrosol Soil Orders.	
Ra	Triassic Arcadia Formation, Rewan Group	4	Undulating to strongly undulating plains and rolling rises, locally flat to undulating upland plateau crestal areas and undulating uplands; with slopes mostly in the range 3-5%.	5	Sandy to loamy surface duplex soils with neutral to acidic, in places strongly acidic sandy clay to medium to heavy clay subsoils (Dr1-5, Dy1-5); Chromosol or Kurosol Soil Orders.	
Ps	Permian Sediments				Sandy to loamy surface duplex soils with neutral to acidic, in places strongly acidic sandy clay to medium to heavy clay subsoils (Dr1-5, Dy1-5); Chromosol or Kurosol Soil Orders.	
Pv	Permian Volcanics	5	Gently to moderately inclined planar to concave intermediate to lower hill and ridge slopes or convex planar dissection slope interfluves; slopes variable mostly within the range 5-12%.	6	Fine sandy, silty or clay loamy surface duplex soils with neutral to alkaline often calcareous, sodic and locally saline medium to heavy clay or heavy clay subsoils; (Db-Dd-Dy1-5); Chromosols, Sodosols or Calcarosols Soil Orders.	
Pfi	Late Permian-Early Triassic Felsic Intrusives				Fine sandy, silty or clay loamy surface duplex soils with neutral to alkaline often calcareous, sodic and locally saline medium to heavy clay or heavy clay subsoils; (Db-Dd-Dy1-5); Chromosols, Sodosols or Calcarosols Soil Orders.	
Pii	Late Permian Intermediate Intrusive Rocks	6	Isolated low rounded hills and rises and low hilly lands mostly with broadly rounded crestal areas and hill slopes in the range 12-25%.	7	Uniform fine-textured (non-cracking) clay soils or gradational clay loam or light clay surface soils with acidic or alkaline often sodic and/or saline medium to heavy clay subsoils – locally incipient cracking clays; (Uf5-6); Dermosol or Hydrosol Soil Orders.	
Ct	Carboniferous Torsdale Volcanics				Uniform fine-textured (non-cracking) clay soils or gradational clay loam or light clay surface soils with acidic or alkaline often sodic and/or saline medium to heavy clay subsoils – locally incipient cracking clays; (Uf5-6); Dermosol or Hydrosol Soil Orders.	
Cr	Carboniferous Rockhampton Group	7	Steep hilly lands with mostly narrow rounded hill and ridge crests and steep irregular planar hill and ridge slopes mostly in the range 20-40%.	8	Uniform fine-textured (cracking) clay soils, locally with thin self-mulching surficial soils with dark grey, brown or black mostly alkaline or alkaline over acidic heavy clay subsoils; (Ug5-Ug6); Vertosols Soil Order.	
Cw	Carboniferous Wandilla Formation				Uniform fine-textured (cracking) clay soils, locally with thin self-mulching surficial soils with dark grey, brown or black mostly alkaline or alkaline over acidic heavy clay subsoils; (Ug5-Ug6); Vertosols Soil Order.	
Dcs	Late Devonian Intermediate Extrusive Rocks	8	Steep to very steep ridges and high hilly lands; mostly with narrow rounded ridge and spur crests, with slopes typically in the range 30-50%, with local sub-vertical rocky scarps and bluffs	9	Uniform, weakly gradational or weak duplex soils with highly organic silty to clay loamy surficial soils and seasonally or permanently saturated often gleyed and saline silty clay or medium to heavy clay subsoils; Um, Dd-Dy, Uf-Ug 5-6 profiles; Organosols, Hydrosols some Vertosol Soil Orders.	
Sf	Silurian-Devonian Volcaniclastic Rocks				Uniform, weakly gradational or weak duplex soils with highly organic silty to clay loamy surficial soils and seasonally or permanently saturated often gleyed and saline silty clay or medium to heavy clay subsoils; Um, Dd-Dy, Uf-Ug 5-6 profiles; Organosols, Hydrosols some Vertosol Soil Orders.	
W	Water Body	9	Very steep high hilly to mountainous lands or very steep to locally sub-vertical or vertical escarpment slopes 35 ->100%.	9	Uniform, weakly gradational or weak duplex soils with highly organic silty to clay loamy surficial soils and seasonally or permanently saturated often gleyed and saline silty clay or medium to heavy clay subsoils; Um, Dd-Dy, Uf-Ug 5-6 profiles; Organosols, Hydrosols some Vertosol Soil Orders.	
D	Disturbed Area – not mapped				Uniform, weakly gradational or weak duplex soils with highly organic silty to clay loamy surficial soils and seasonally or permanently saturated often gleyed and saline silty clay or medium to heavy clay subsoils; Um, Dd-Dy, Uf-Ug 5-6 profiles; Organosols, Hydrosols some Vertosol Soil Orders.	
Note:	Refer to EIS Report Section 1.3 for more detailed descriptions of Geological Regimes.	Example: Terrain Unit Qa2/6-7 Qa (Geological Regime) 2 (Landform) 6-7 (Soils)			Notes: - (1) – Soil profile form and texture class (2) – Principal Profile Form (Northcote, 1974) (3) – Australian Soil Classification (Isbell, 1996) Dual symbols eg (2-7) indicate both soil types may be present.	



7.3.5 Good Quality Agricultural Land (GQAL)

An assessment of the agricultural land capability of the area was conducted during the EIS (URS, 2009) to provide a benchmark of existing/potential agricultural land use. Land within the study area was identified in accordance with State Planning Policy 1/92: *Development and the Conservation of Agricultural Land*, the assessment was based on the four class system for defining GQAL as detailed in the Planning Guidelines - Department of Primary Industries (DPI) and the Department of Housing Local Government and Planning (DPI/DHLGP - 1993).

Four classes of agricultural land have been defined in Queensland, are summarised in Table 7.2:

Table 7.2 Good Quality Agricultural Land Descriptions

Class	Description
Class A	Cropland – Land that is suitable for current and potential crops with limitations to production which range from none to moderate levels. Considered to be GQAL in all areas
Class B	Limited cropland – Land that is marginal for current and potential crops due to severe limitations; and suitable for pastures. Engineering and/or agronomic improvements may be required before the land is considered suitable for cropping. Considered to be GQAL in most areas
Class C	Pasture land – Land that is suitable only for improved or native pastures due to limitations which preclude continuous cultivation for crop production; but some areas may tolerate a short period of ground disturbance for pasture establishment. Not considered to be GQAL
Class D	Non-agricultural land – Land is not suitable for agricultural uses due to extreme limitations. This may be undisturbed land with significant habitat, conservation and/or catchment values or land that may be unsuitable because of very steep slopes, shallow soils, rock outcrop or poor drainage. Not considered to be GQAL

Source: DPI/DHLGP 1993

Within Class C land, three sub-classes have been identified as follows:

- *C1: Some areas may tolerate an occasional cultivation for improved pasture and suitable for native pastures.*
- *C2: Areas primarily suited to grazing of native pastures, with or without the addition of improved pasture species but without ground disturbance.*
- *C3: Land that is suited to restricted light grazing of native pastures in accessible areas, otherwise steep to very steep hilly lands more suited for forestry, conservation or catchment protection.*

Class A land in all areas is considered to be GQAL. In some areas, Class B land (where agricultural land is scarce) and better quality Class C land (C1) (where pastoral industries predominate), are also considered to be GQAL. For the Mainland GTP RoW, Classes A, B and C1 are considered to be GQAL.

Agricultural land classes in the Mainland GTP RoW have been determined using the Terrain Units mapping. Agricultural land classes have been assigned to the Terrain Units based primarily on the regional compilation and mapping (1:250,000) of GQAL in the Central West Region of Queensland – Department of Natural Resources and Water (NRW, 2008). In some areas this mapping has been modified to reflect the more detailed terrain unit mapping, with the aim of improving the scale and accuracy of the NRW (2008) mapping. Figure 7.4 shows the Terrain Unit based GQAL classes assigned to the Mainland GTP RoW. GQAL units for areas beyond the 1 km buffer area mapping based on the Queensland Government (NRW, 2008) data are also presented on the figure for comparison.



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 10km
- 5km

Strategic Cropping Land

Agricultural Land Class

- A
- A, C1
- A-C2
- B
- C1
- C2
- C3
- C-D
- D

Good Quality Agricultural Land (DERM)

- A
- A1
- A2
- B
- B1
- B2
- C
- C1
- C2
- C3
- D
- W*

Rail

Watercourse

Major Road

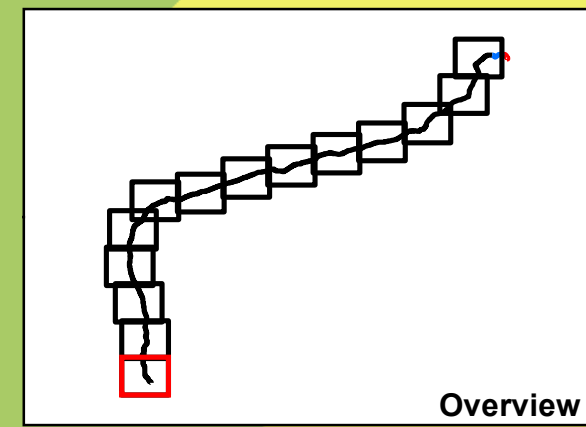
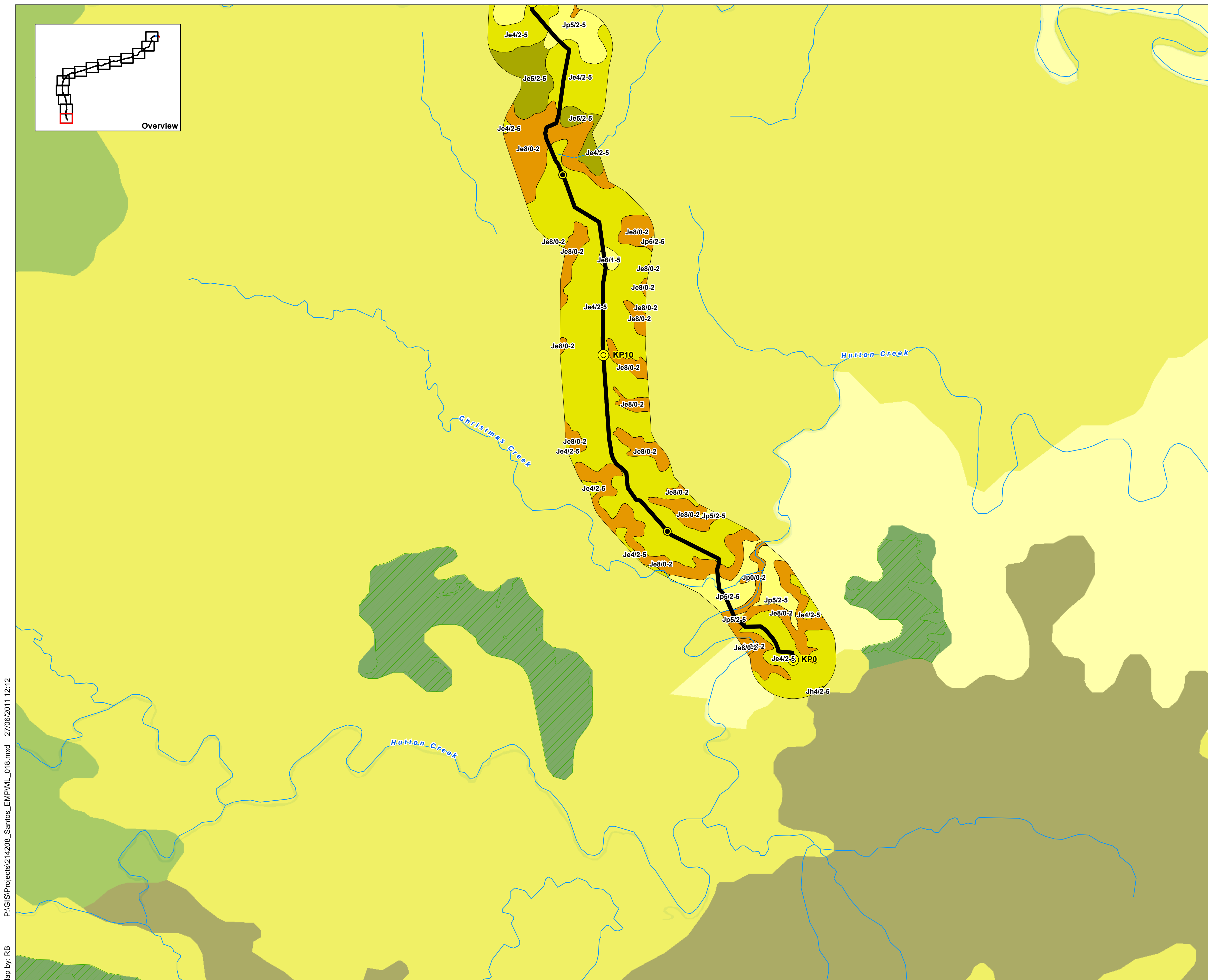
Note: All figures should be reviewed in conjunction with Table 7.1 "Generic Key to the Identification of Terrain Units", URS 2009.

Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Strategic Cropping Land: Department of Management and Resource Management, Sep 2010.
 Good Quality Agricultural Land: Department of Management and Resource Management, Feb 2011.
 GLNG Terrain Units: Supplementary EIS, URS, 2009.

Good Quality Agricultural Land and Strategic Cropping Land Figure 7.4 (Page 1 of 14)

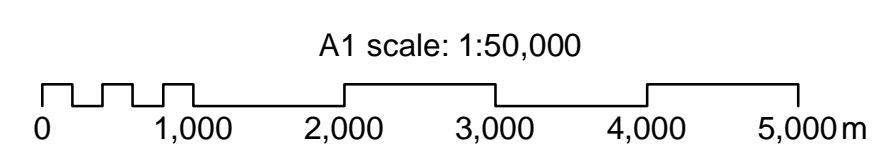
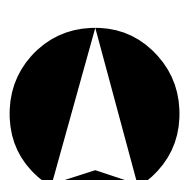
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Overview

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Map by: RB



GLNG No: 3381-40-0408
 Coordinate system: GCS_GDA_1994



Mainland GTP EM Plan

- Gas Transmission Pipeline (GTP)
- Mainland GTP EM Plan
 - Marine Crossing GTP EM Plan
 - Curtis Island GTP EM Plan
- Kilometre Post Distance Marker
- 10km
 - 5km
- Strategic Cropping Land
- Agricultural Land Class
- A
 - A, C1
 - A-C2
 - B
 - C1
 - C2
 - C3
 - C-D
 - D
- Good Quality Agricultural Land (DERM)
- A
 - A1
 - A2
 - B
 - B1
 - B2
 - C
 - C1
 - C2
 - C3
 - D
 - W*
- Rail
 - Watercourse
 - Major Road

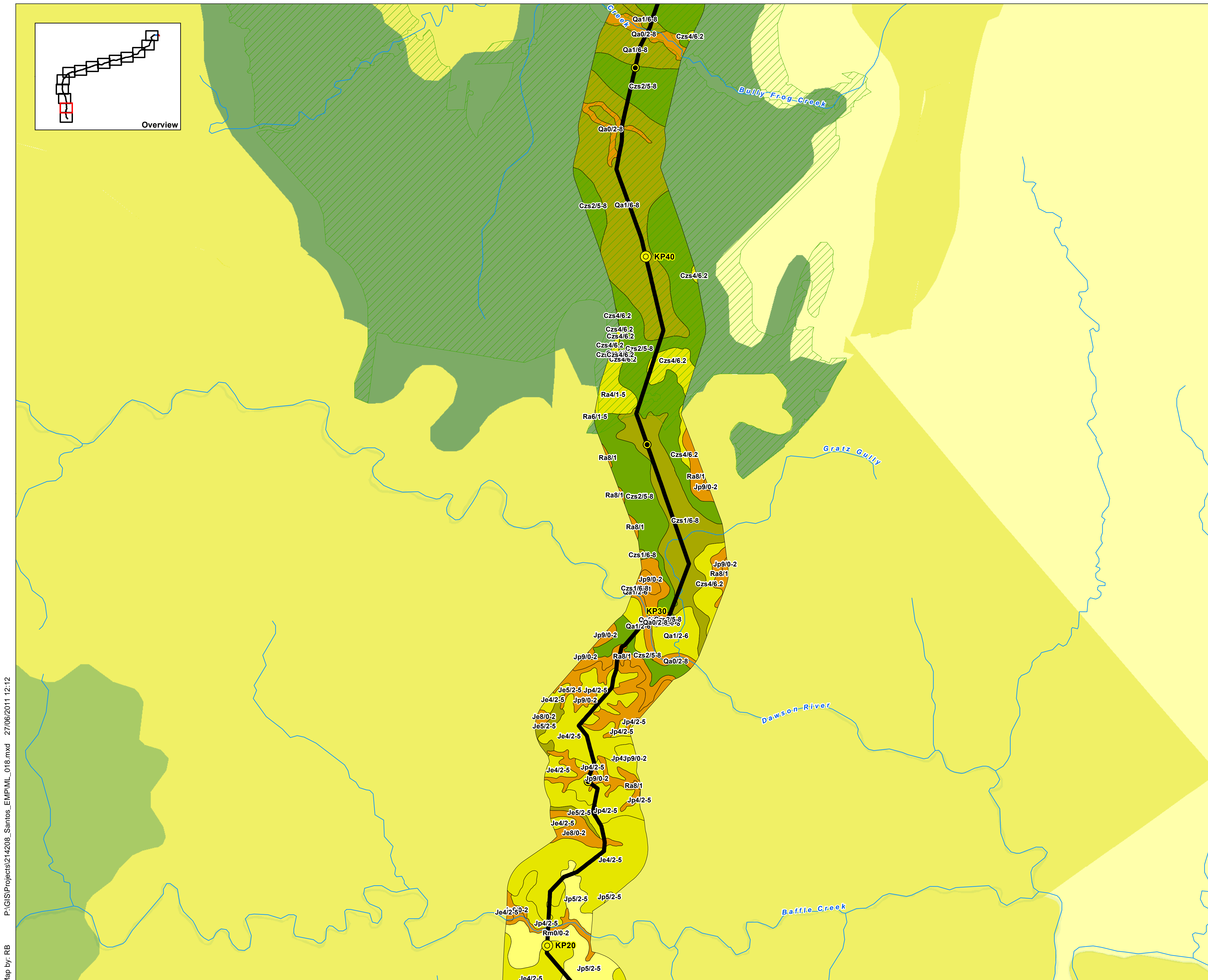
Note: All figures should be reviewed in conjunction with Table 7.1 "Generic Key to the identification of Terrain Units", URS 2009.

Source:
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GLNG Terrain Units: Supplementary EIS, URS, 2009.

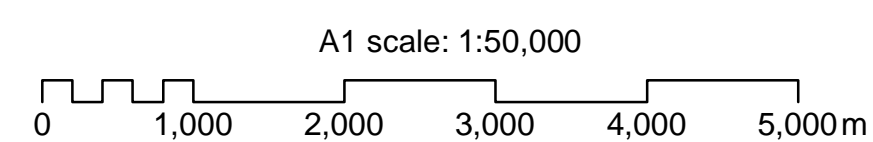
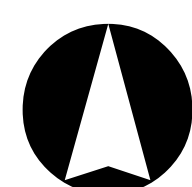
Good Quality Agricultural Land and Strategic Cropping Land Figure 7.4 (Page 2 of 14)

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Map by: RB



GLNG No: 3381-40-0408
Coordinate system: GCS_GDA_1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 10km
- 5km

Strategic Cropping Land

Agricultural Land Class

- A
- A, C1
- A-C2
- B
- C1
- C2
- C3
- C-D
- D

Good Quality Agricultural Land (DERM)

- A
- A1
- A2
- B
- B1
- B2
- C
- C1
- C2
- C3
- D
- W*

Rail

Watercourse

Major Road

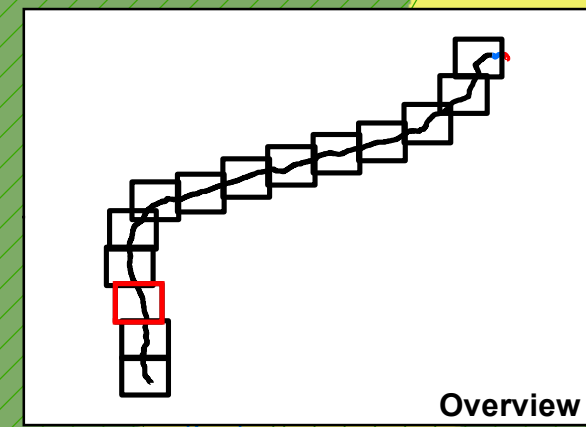
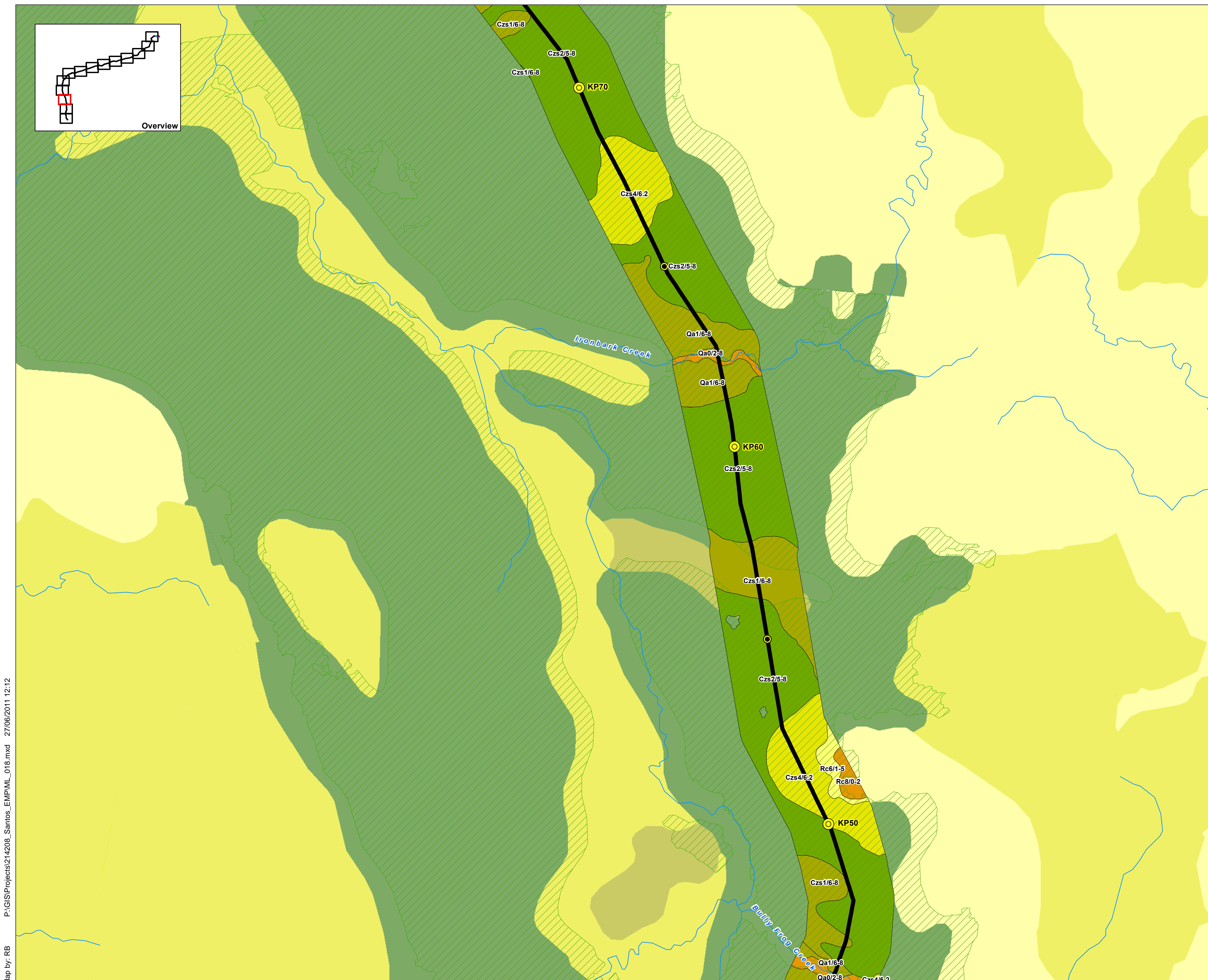
Note: All figures should be reviewed in conjunction with Table 7.1 "Generic Key to the Identification of Terrain Units", URS 2009.

Source:
Gas Transmission Pipeline (GTP): Santos, Jan 2011.
Strategic Cropping Land: Department of Management and Resource Management, Sep 2010.
Good Quality Agricultural Land: Department of Management and Resource Management, Feb 2011.
GLNG Terrain Units: Supplementary EIS, URS, 2009.

Good Quality Agricultural Land and Strategic Cropping Land Figure 7.4 (Page 3 of 14)

Date: 27/06/2011

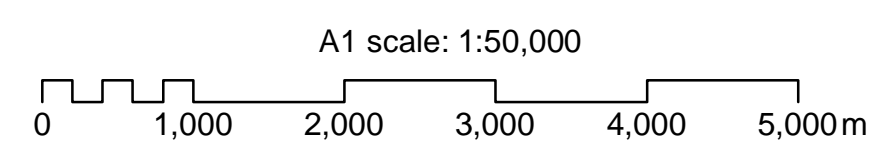
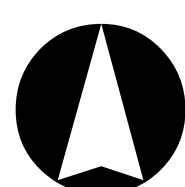
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Overview

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Map by: RB



GLNG No: 3381-40-0408
Coordinate system: GCS_GDA_1994



Mainland GTP EM Plan

- Gas Transmission Pipeline (GTP)
- Mainland GTP EM Plan
 - Marine Crossing GTP EM Plan
 - Curtis Island GTP EM Plan

- Kilometre Post Distance Marker
- 10km
 - 5km

- Strategic Cropping Land

Agricultural Land Class

- A
- A, C1
- A-C2
- B
- C1
- C2
- C3
- C-D
- D

Good Quality Agricultural Land (DERM)

- A
- A1
- A2
- B
- B1
- B2
- C
- C1
- C2
- C3
- D
- W*

Rail

Watercourse

Major Road

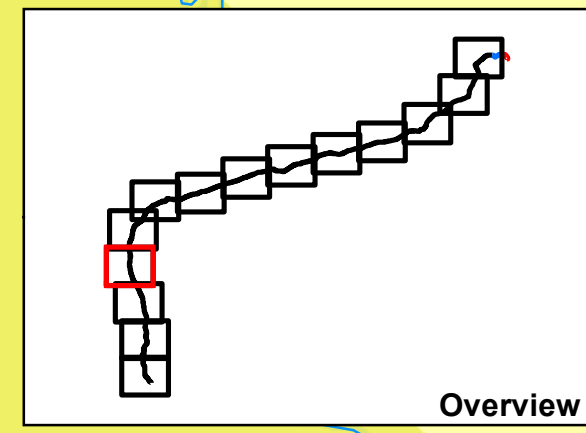
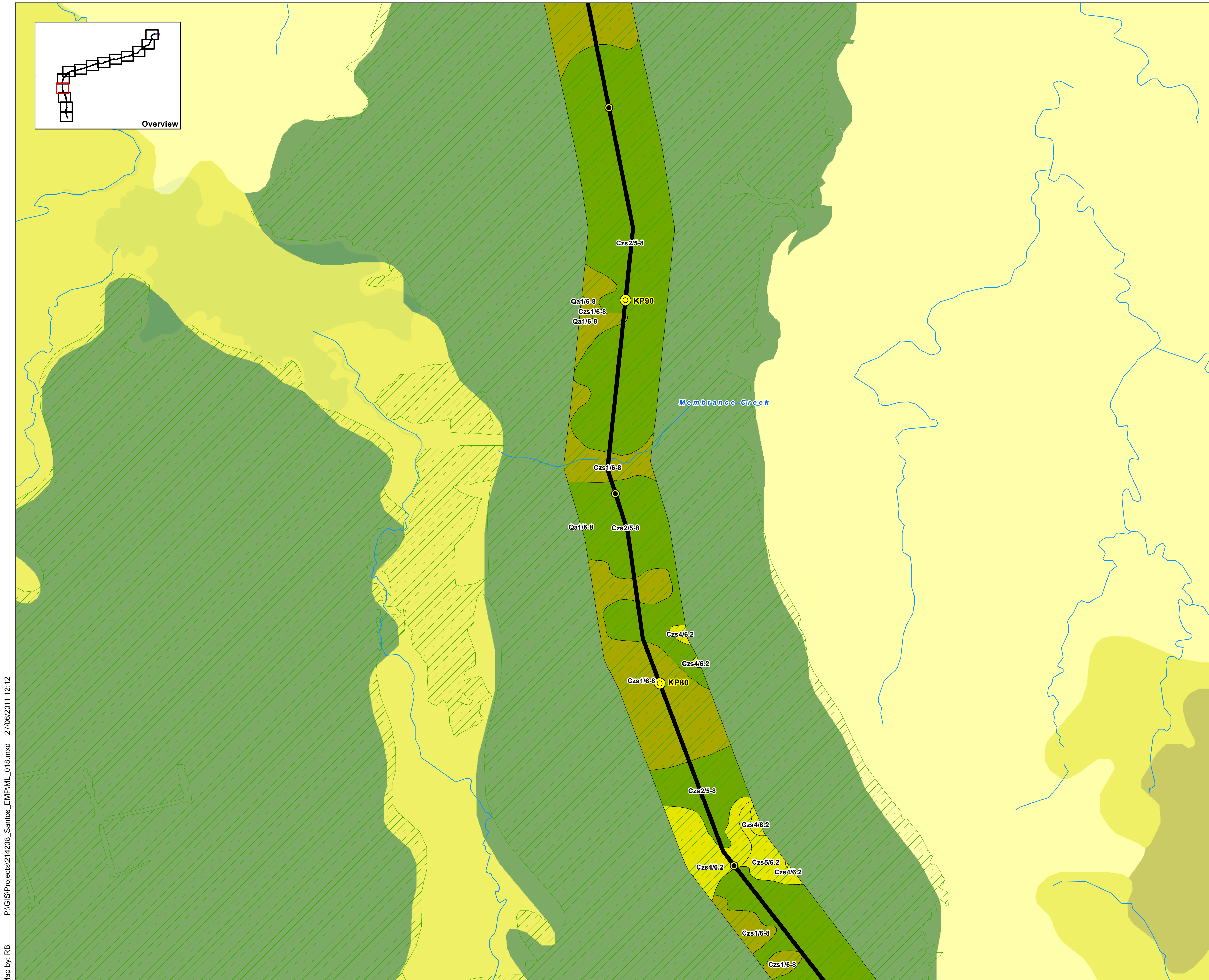
Note: All figures should be reviewed in conjunction with Table 7.1 "Generic Key to the Identification of Terrain Units", URS 2009.

Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Strategic Cropping Land: Department of Management and Resource Management, Sep 2010.
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 GLNG Terrain Units: Supplementary EIS, URS, 2009.

Good Quality Agricultural Land and Strategic Cropping Land Figure 7.4 (Page 4 of 14)

Date: 27/06/2011

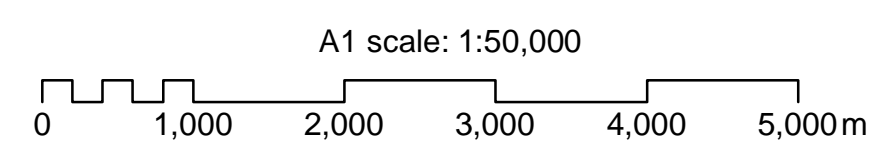
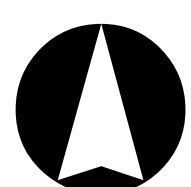
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Overview

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Map by: RB



GLNG No: 3381-40-0408
 Coordinate system: GCS_GDA_1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

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Kilometre Post Distance Marker

- 10km
- 5km

Strategic Cropping Land

Agricultural Land Class

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Rail

Watercourse

Major Road

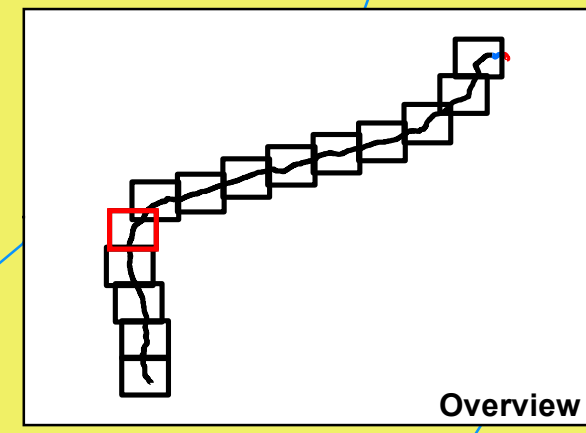
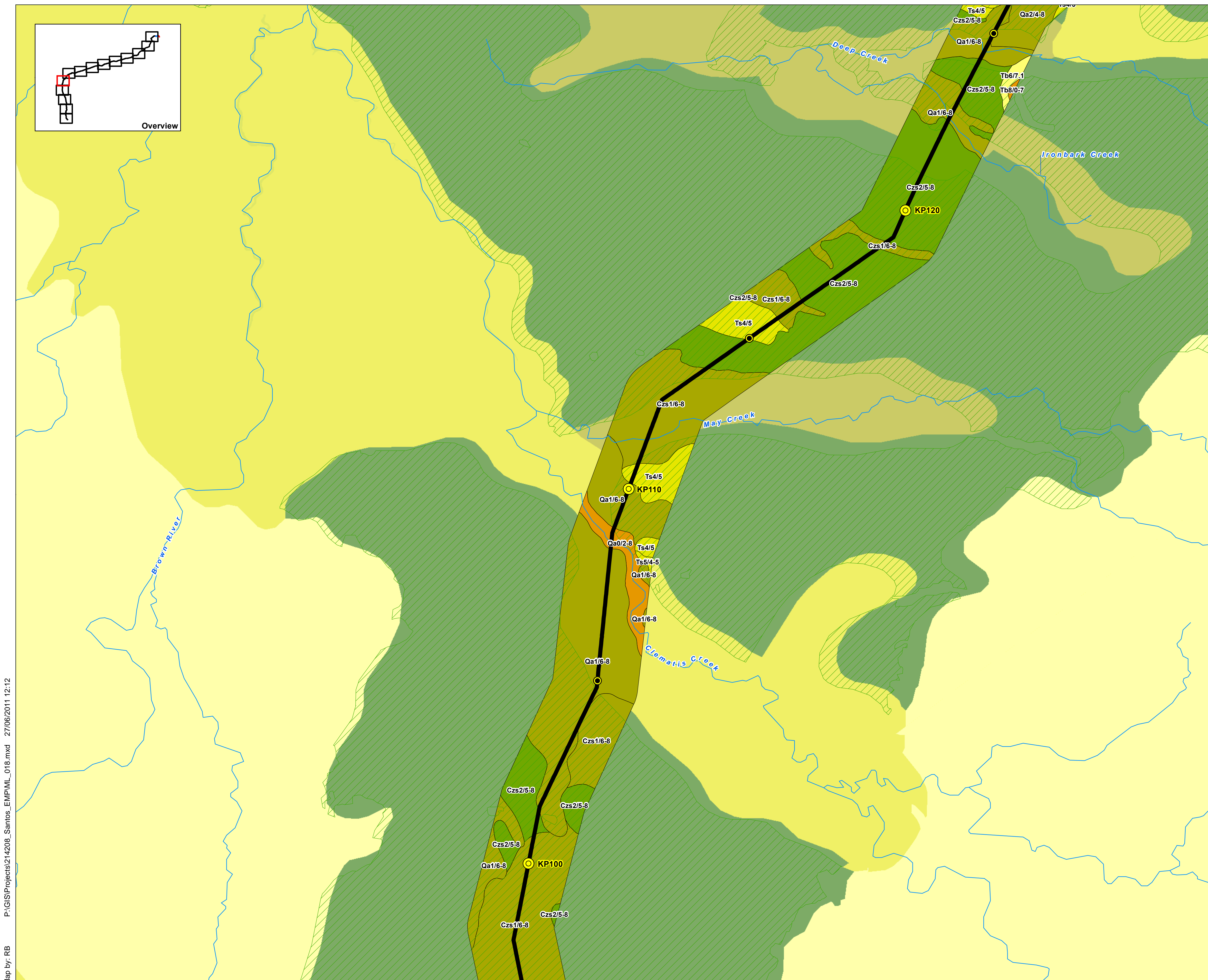
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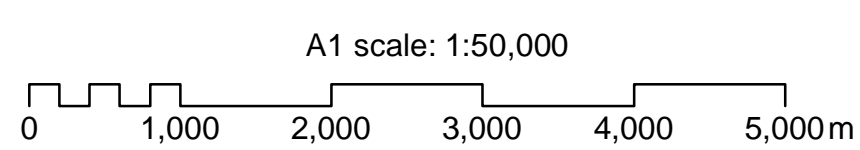
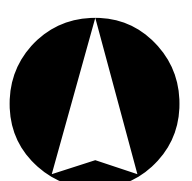
Good Quality Agricultural Land and Strategic Cropping Land Figure 7.4 (Page 5 of 14)

Date: 27/06/2011

Version: c



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Map by: RB



GLNG No: 3381-40-0408
 Coordinate system: GCS_GDA_1994



Mainland GTP EM Plan

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 - Curtis Island GTP EM Plan

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- C3
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- Rail
- Watercourse
- Major Road

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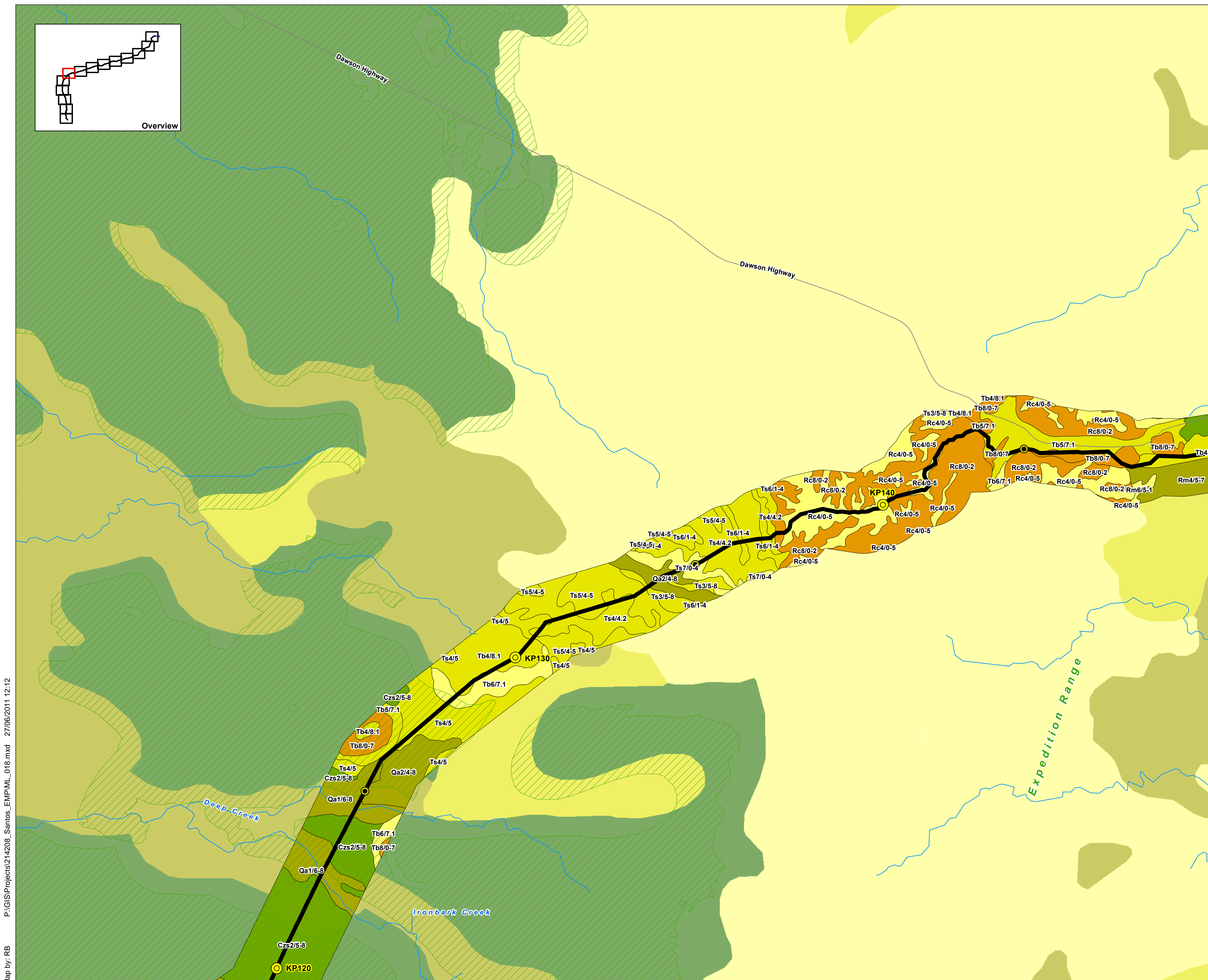
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 GLNG Terrain Units: Supplementary EIS, URS, 2009.

Good Quality Agricultural Land and Strategic Cropping Land

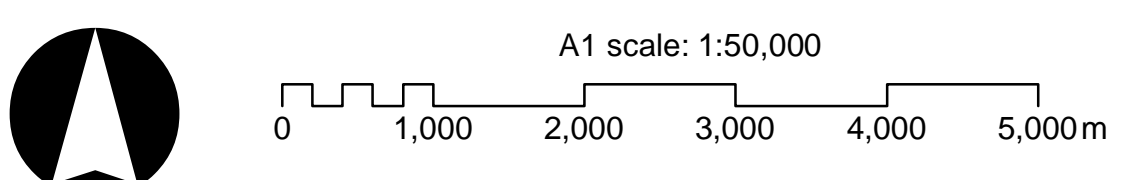
Figure 7.4 (Page 6 of 14)

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Version: c



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Map by: RB



GLNG No: 3381-40-0408
 Coordinate system: GCS_GDA_1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 10km
- 5km

Strategic Cropping Land

Agricultural Land Class

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Good Quality Agricultural Land (DERM)

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- W*

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- Watercourse
- Major Road

Note: All figures should be reviewed in conjunction with Table 7.1 "Generic Key to the Identification of Terrain Units", URS 2009.

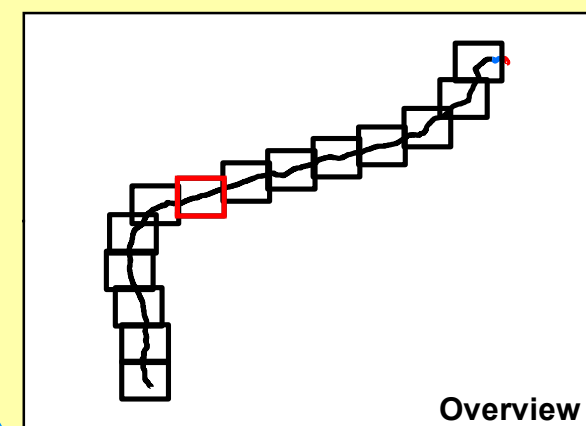
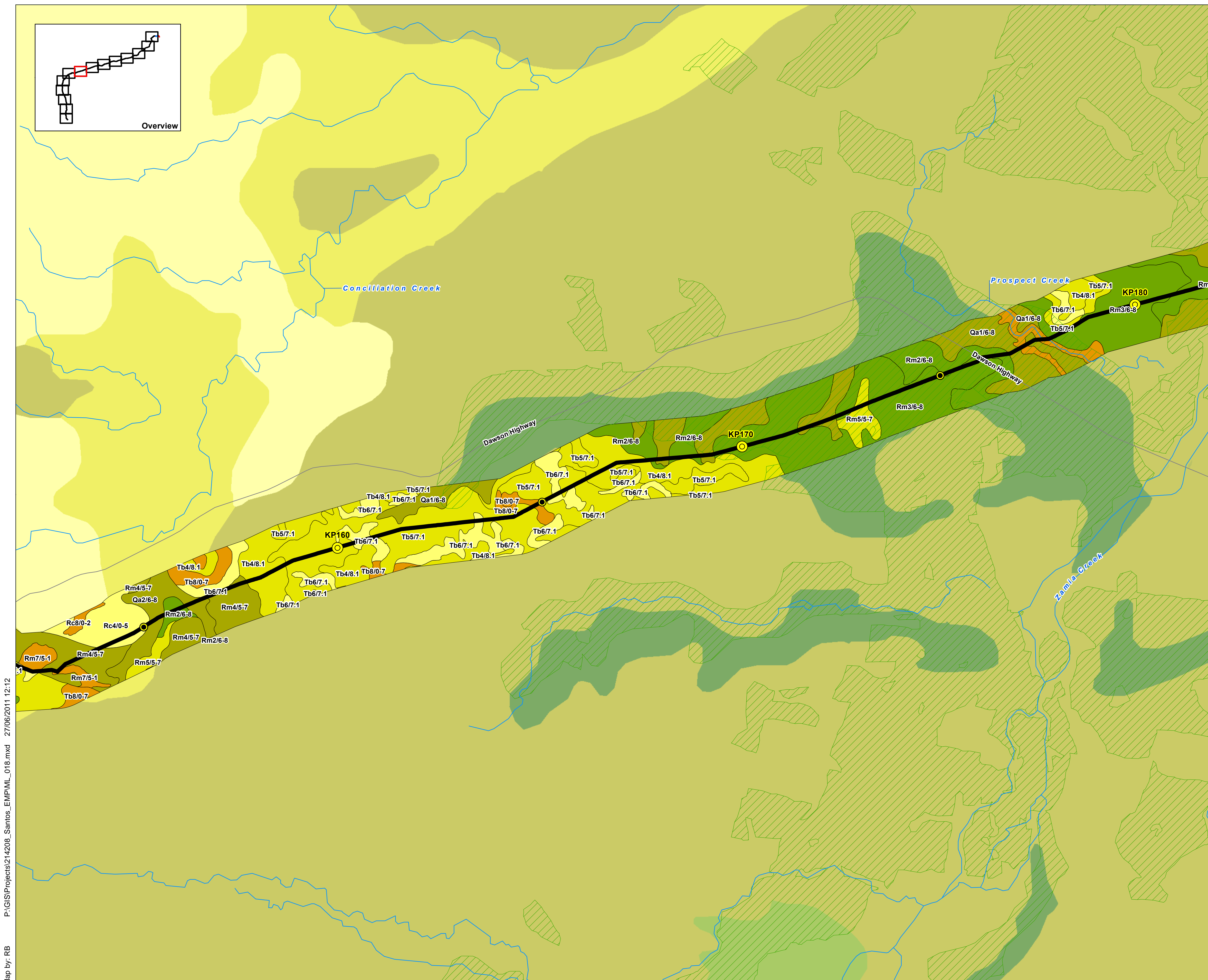
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Good Quality Agricultural Land and Strategic Cropping Land

Figure 7.4 (Page 7 of 14)

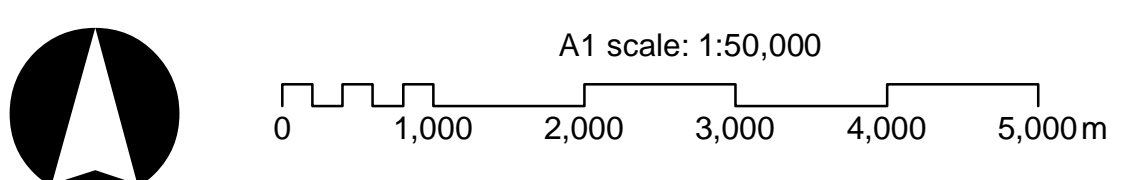
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Map by: RB



GLNG No: 3381-40-0408
 Coordinate system: GCS_GDA_1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

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- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 10km
- 5km

Strategic Cropping Land

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Good Quality Agricultural Land (DERM)

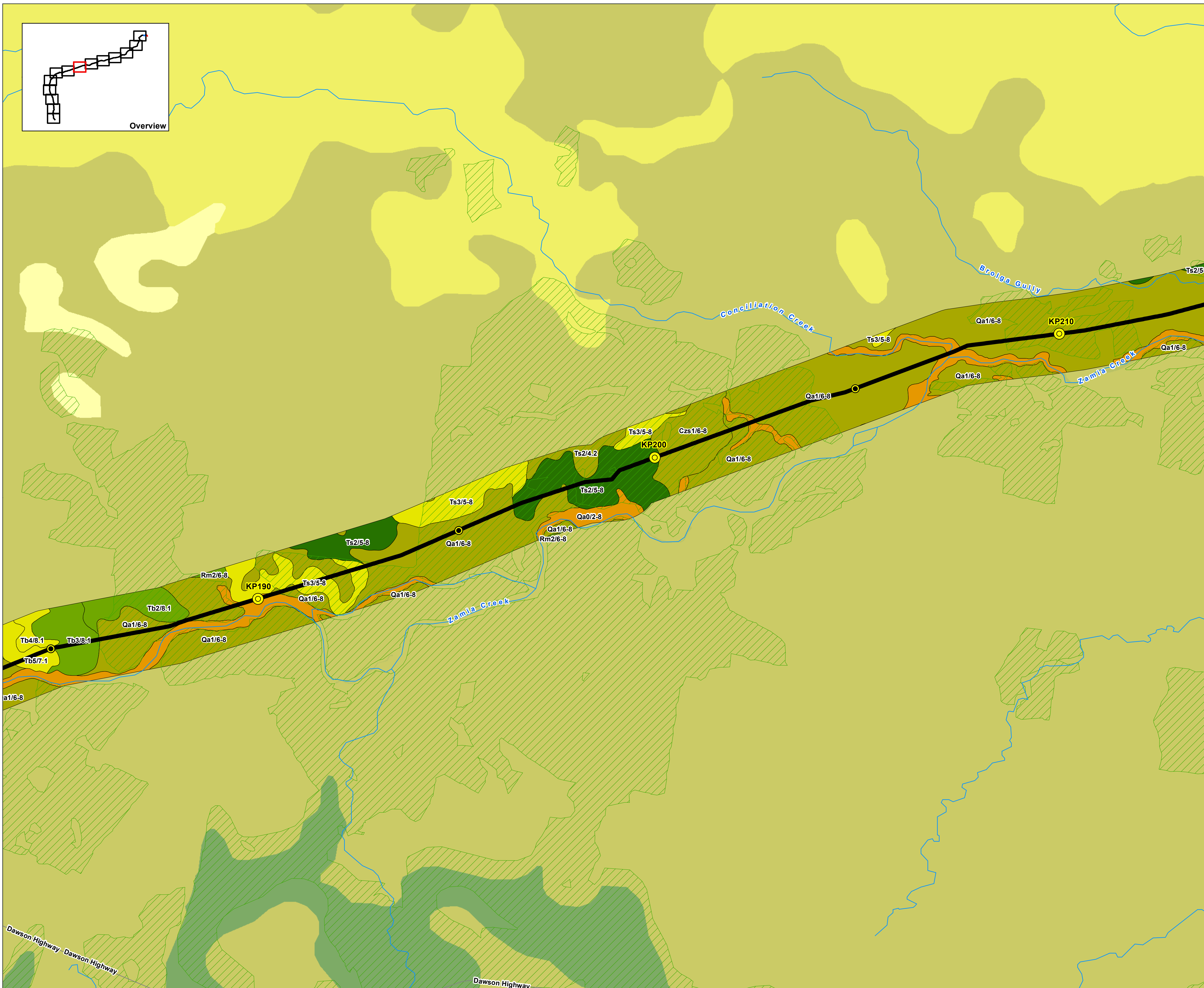
- A
- A1
- A2
- B
- B1
- B2
- C
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- C3
- D
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- Rail
- Watercourse
- Major Road

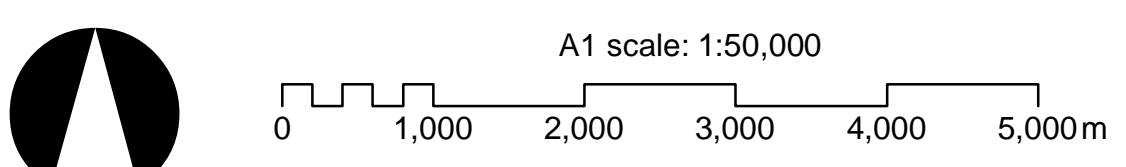
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Good Quality Agricultural Land and Strategic Cropping Land Figure 7.4 (Page 8 of 14)



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Date: 27/06/2011

Version: c



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

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Kilometre Post Distance Marker

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Strategic Cropping Land

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- C3
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Rail

Watercourse

Major Road

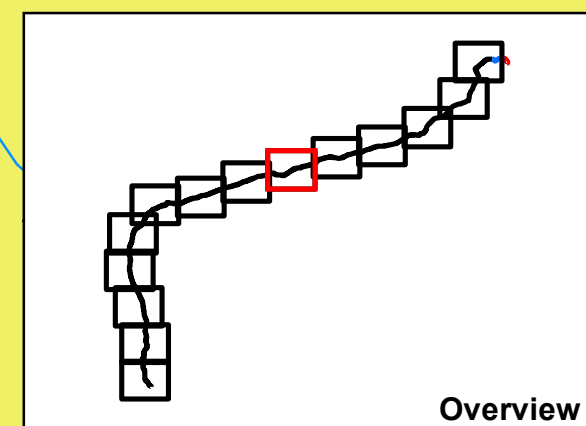
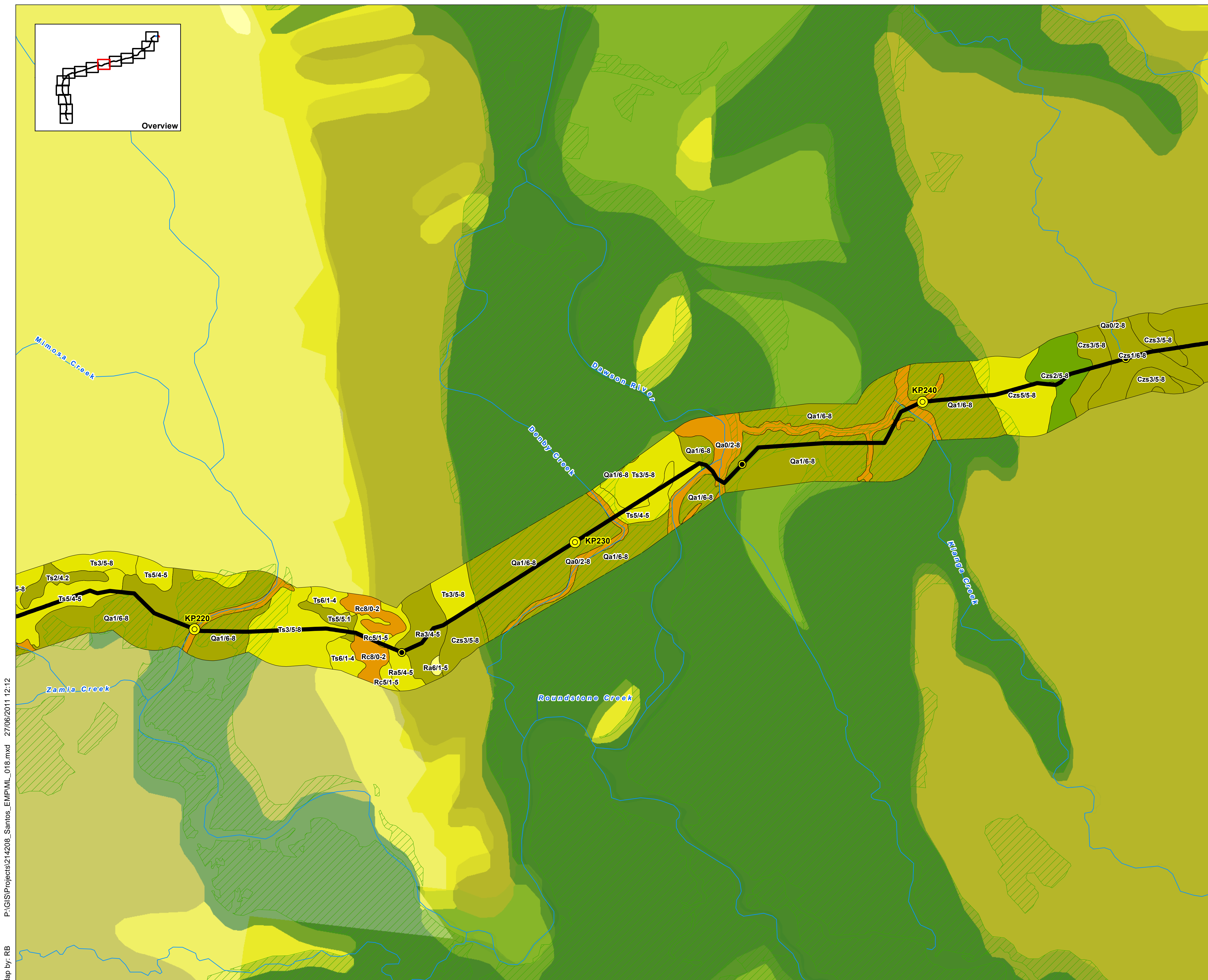
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Good Quality Agricultural Land and Strategic Cropping Land Figure 7.4 (Page 9 of 14)

Date: 27/06/2011

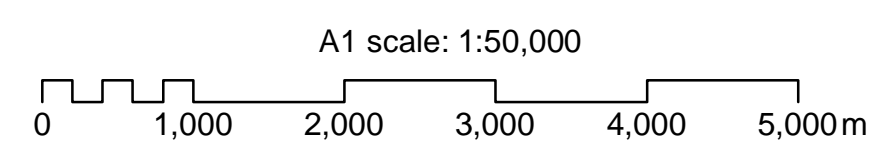
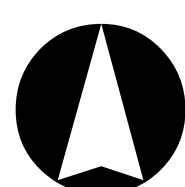
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Overview

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Map by: RB



GLNG No: 3381-40-0408
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Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
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Kilometre Post Distance Marker

- 10km
- 5km

Strategic Cropping Land

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Rail

Watercourse

Major Road

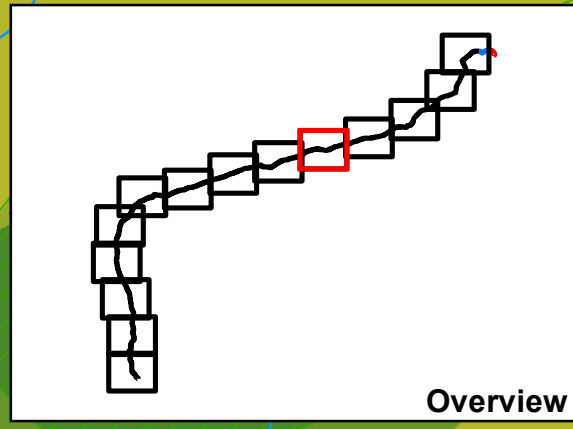
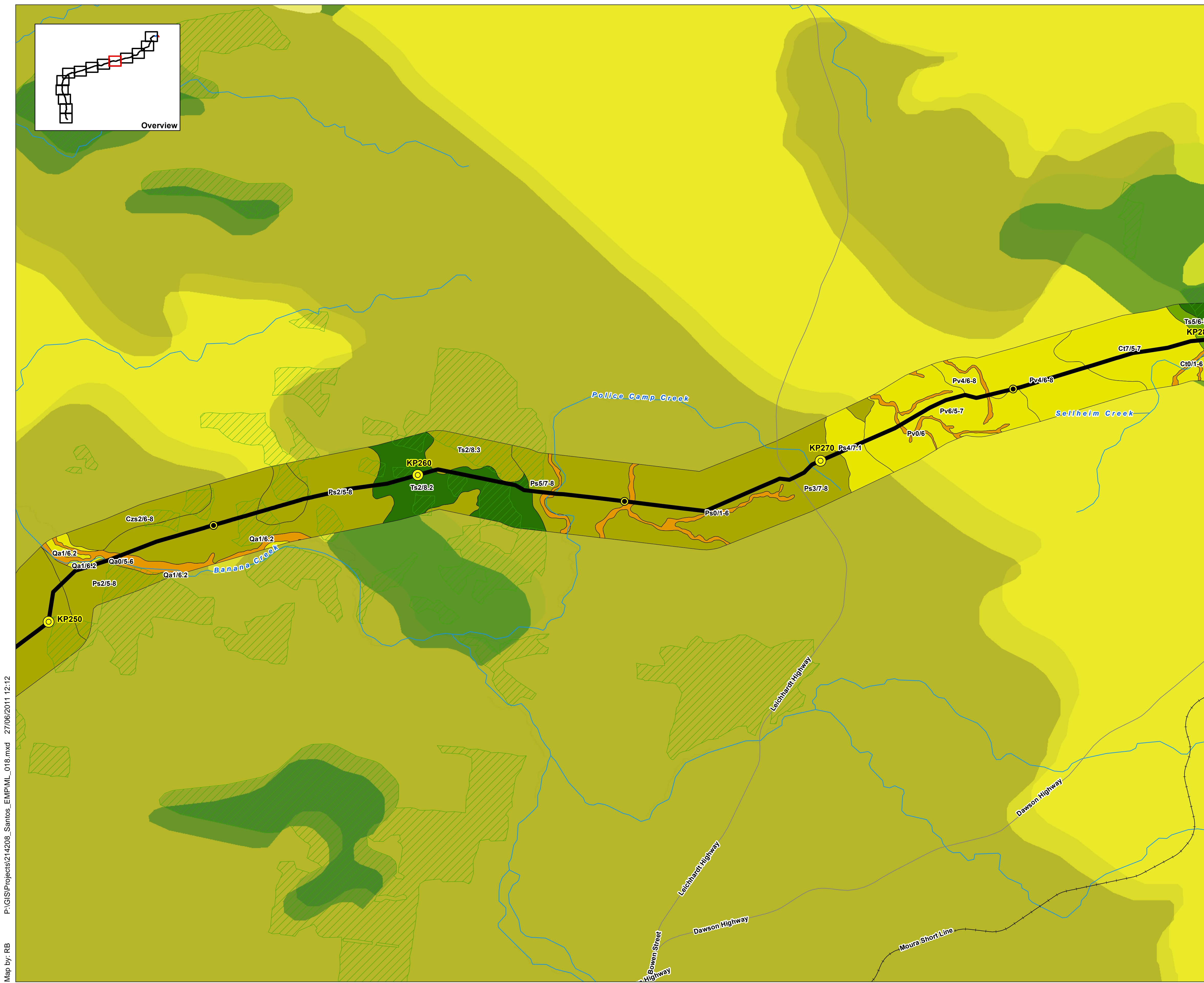
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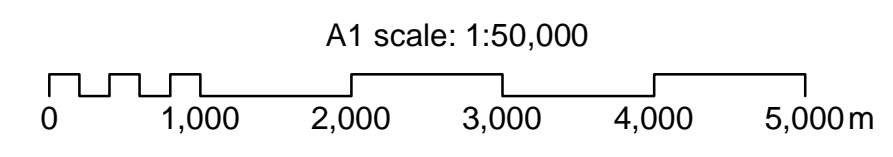
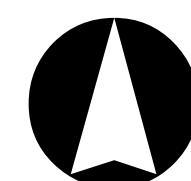
Good Quality Agricultural Land and Strategic Cropping Land Figure 7.4 (Page 10 of 14)

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Version: c



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Map by: RB



GLNG No: 3381-40-0408
 Coordinate system: GCS_GDA_1994



Mainland GTP EM Plan

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- Kilometre Post Distance Marker
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- Strategic Cropping Land

Agricultural Land Class

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- A, C1
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- C1
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- C-D
- D

Good Quality Agricultural Land (DERM)

- A
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- C1
- C2
- C3
- D
- W*

- Rail
- Watercourse
- Major Road

Note: All figures should be reviewed in conjunction with Table 7.1 "Generic Key to the Identification of Terrain Units", URS 2009.

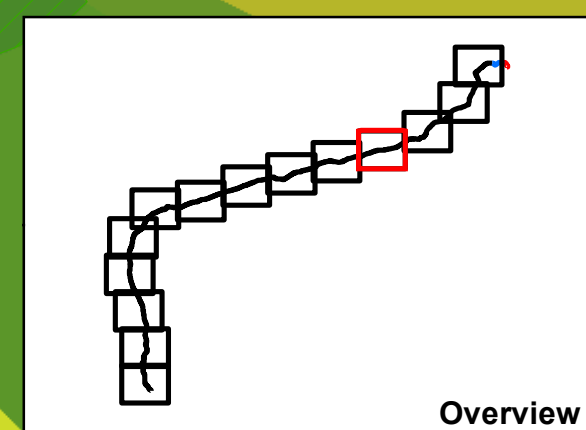
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 GLNG Terrain Units: Supplementary EIS, URS, 2009.

Good Quality Agricultural Land and Strategic Cropping Land

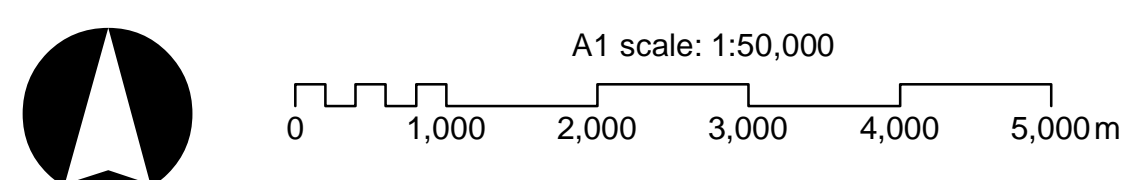
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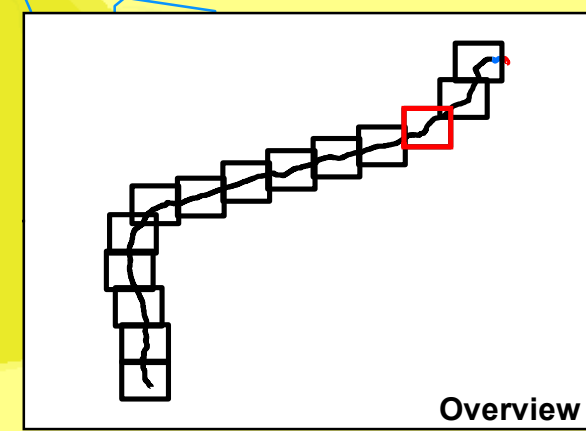
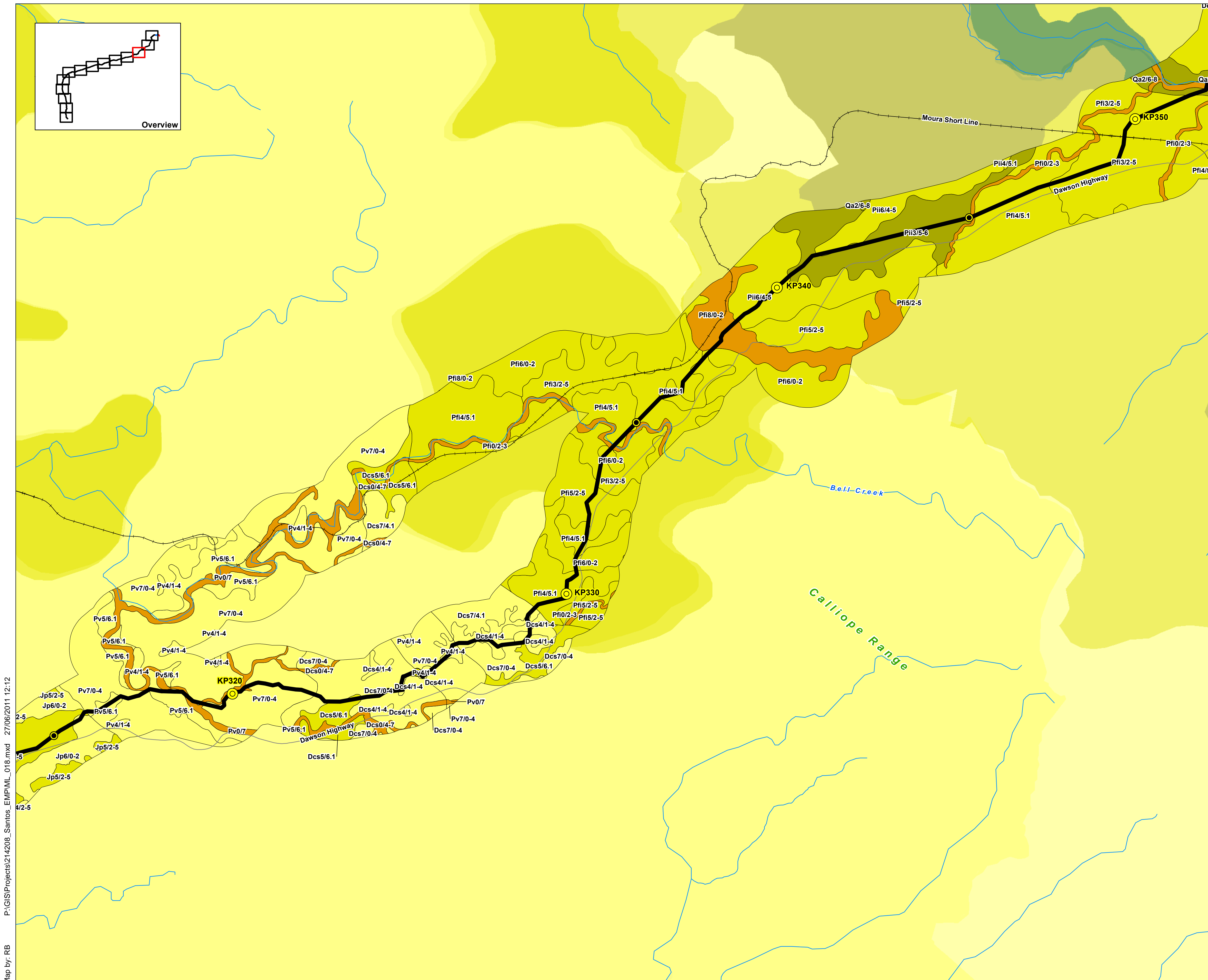
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Good Quality Agricultural Land and Strategic Cropping Land

Figure 7.4 (Page 12 of 14)

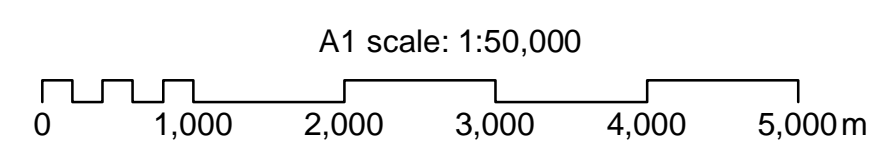
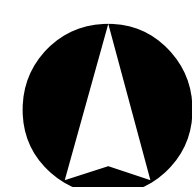
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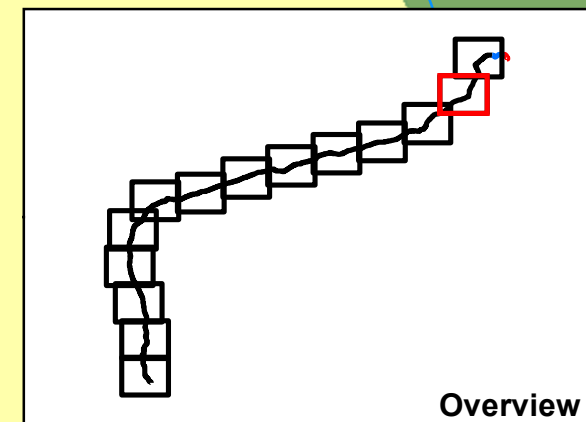
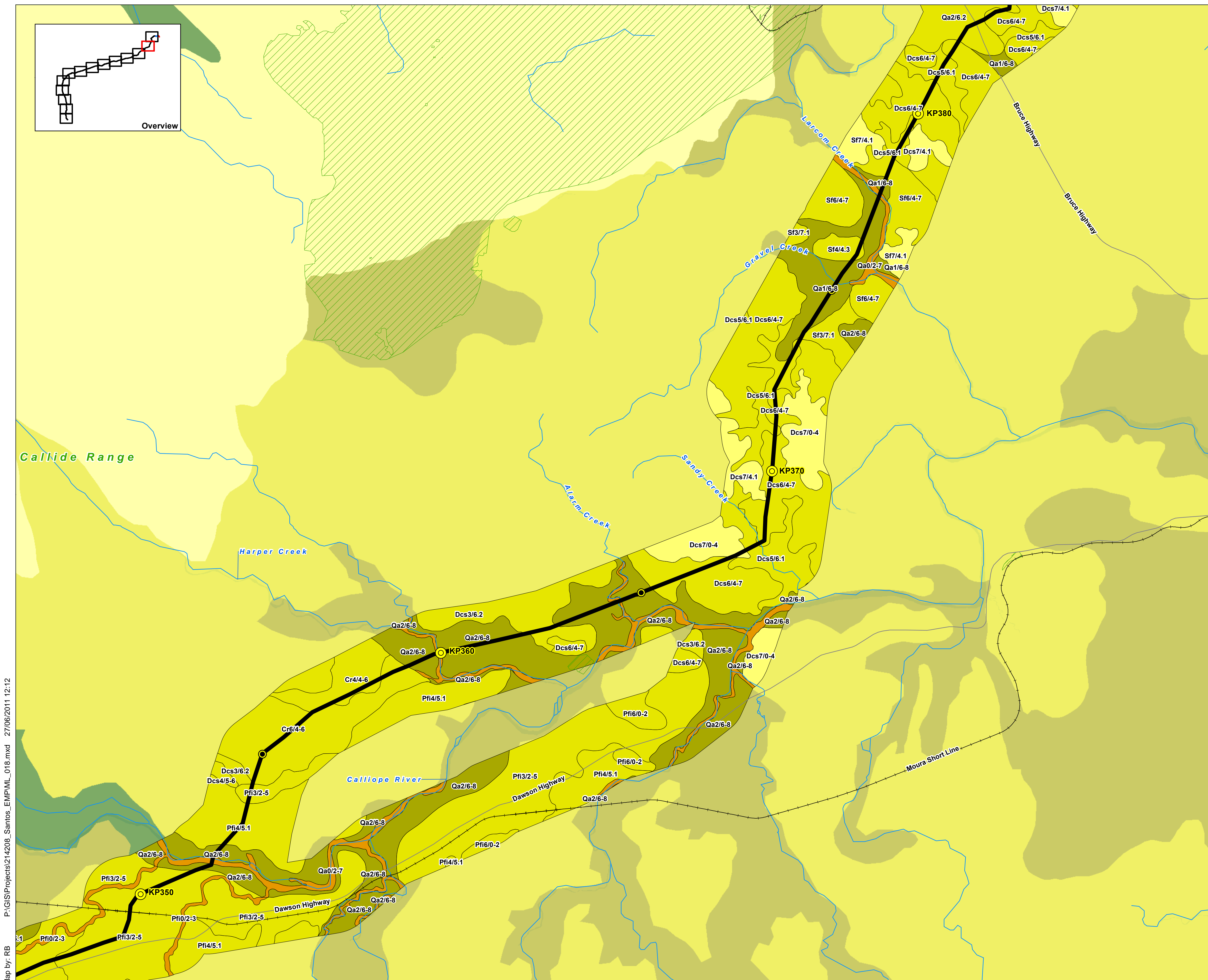
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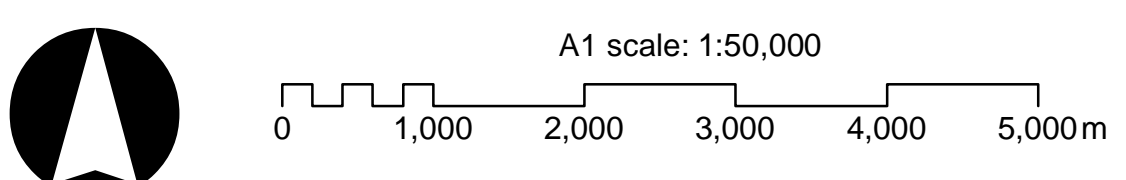
Figure 7.4 (Page 13 of 14)

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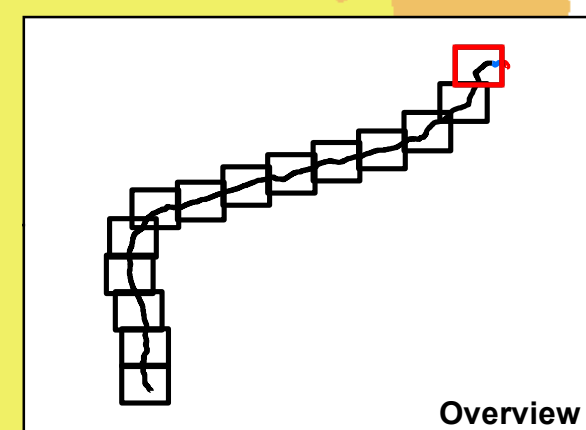
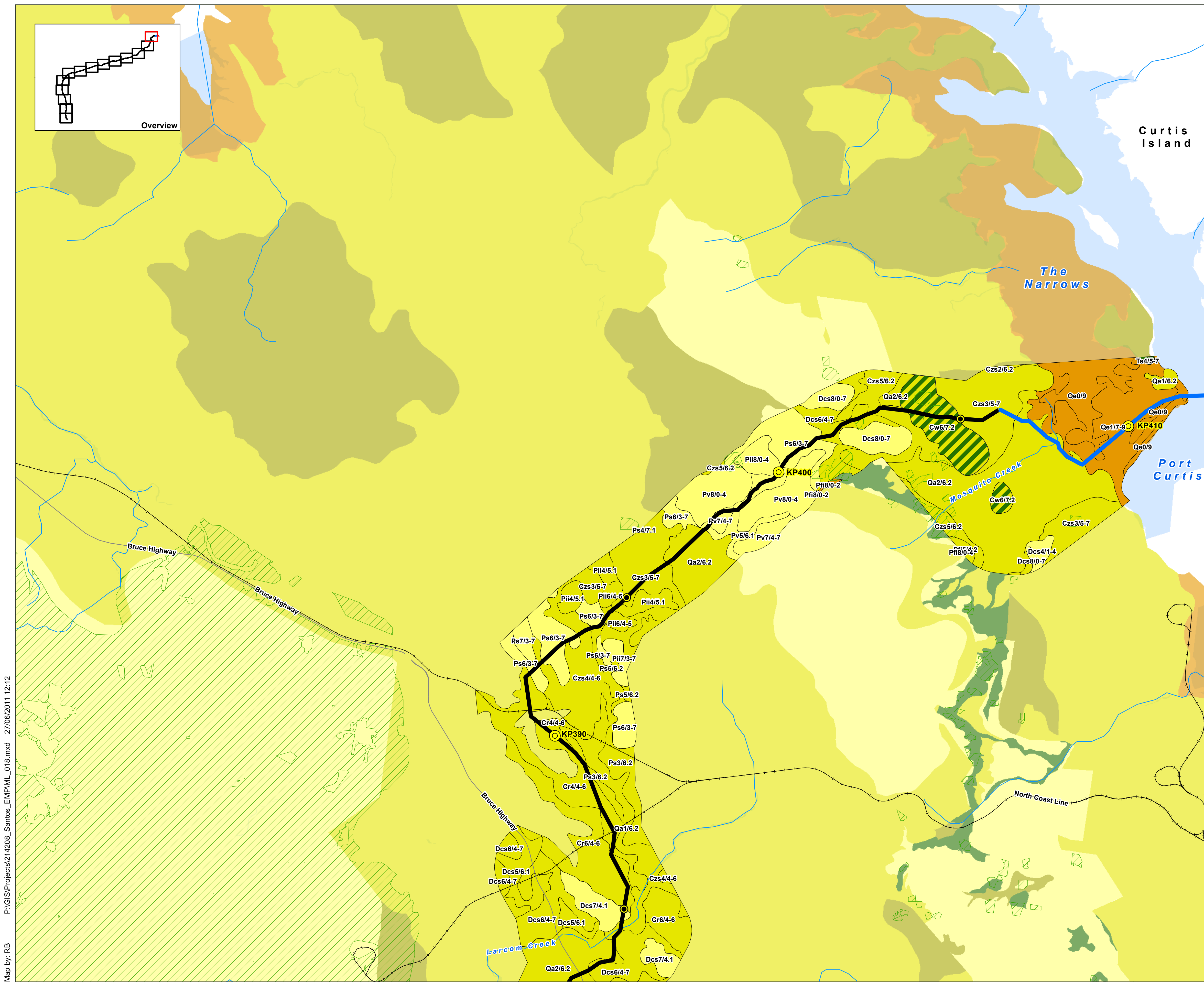
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Good Quality Agricultural Land and Strategic Cropping Land Figure 7.4 (Page 14 of 14)

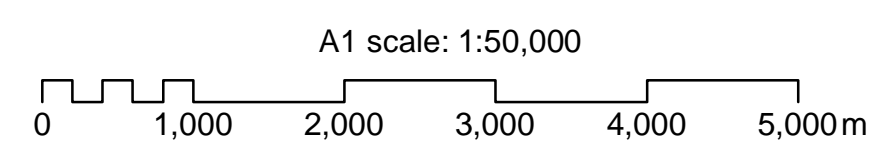
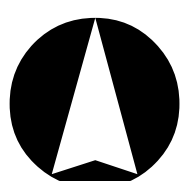
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Map by: RB



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For the Mainland GTP RoW, generally soil types 6-8 are classified as GQAL. Smaller pockets of Group 4 and 5 soils are also classified as GQAL.

The mapping illustrates that the Mainland GTP RoW traverses GQAL land classes A through to D. Significant lengths of Class A and B land is traversed in the Arcadia Valley and East of the Dawson Highway to North of Burnett Highway. The majority of land intercepted by the Mainland GTP RoW is classified as Class C.

It has been calculated that 7.4% of the pipeline length will pass through Class A land; 9.6% will pass through Class B land and 77.6% will pass through Class C land (with 34.9% of that being Class C1). The remaining mainland GTP RoW will pass through Class D non-agricultural land.

7.3.6 Strategic Cropping Land

The Queensland Government defines Strategic Cropping Land, as “*land that is suitable and available for current and potential future cropping with limitations to production that range from moderate to none*” Department of Infrastructure and Planning (DPI 2010). Draft trigger maps released identified around 4% of Queensland's land mass as having potential for strategic cropping and being eligible for possible protection.

A review of the draft trigger maps indicated that the Mainland GTP RoW traverses many parcels of land identified as Strategic Cropping Land, with approximately 140 km of the Mainland GTP RoW located within Strategic Cropping Land. This is represented in Figure 7.4.

It is evident from an overlay of the draft trigger maps and the GQAL mapping, that land classified as agricultural land classes A and B by government mapping has been deemed to be Strategic Cropping Land. However, as discussed in the previous section, boundaries of agricultural land classes have been refined for the Mainland GTP RoW using information gathered in the Terrain Unit analysis. As a result, Project GQAL mapping differs from Government sourced GQAL mapping, which in turn has led to anomalies in the mapping of strategic cropping land versus GQAL.

It is understood that DPI recognises the draft trigger maps are not a definitive measure of the extent of strategic cropping land and field investigations would be required to determine extents of Strategic Cropping Land. The requirements for ground truthing Terrain Unit and GQAL/Strategic Cropping Land are addressed further in the management and mitigation measures.

7.3.7 Salinity and erosion potential

Salinity

Salinity refers to the concentration of soluble salts in the soil water. Salinity can adversely affect plant growth and/or land use. At high concentrations, soil salinity can increase the potential for corrosion of buried steel and/or concrete.

Salinity in the Project area has been assessed based on the Electrical Conductivity (EC) (1:5 H₂O) and soil texture. The criteria used to assess the levels of soil salinity are given below.

- *Low (L)* – EC (mS/cm) <0.25 (sand), <0.4 (loam), <0.55 (clay) – Nil to low salinity
- *Moderate (M)* – EC (mS/cm) 0.25-0.47 (sand), 0.4-0.8 (loam), 0.55-1.15 (clay) – Medium salinity
- *High (H)* – EC (mS/cm) >0.47 (sand), >0.8 (loam), >1.15 (clay) – High to very high salinity

In the Mainland GTP RoW, saline soils occur in terrain units associated with the Quaternary estuarine deposits (Qe) and in the Silurian-Devonian extrusive and volcanoclastic geological regimes (Dcs and Sf) (Refer to Geological Regime Figure 7.1). Moderately to highly saline soils most likely occur in the Quaternary alluvial deposits, mainly in terrain unit Qa1/6-8 and in the older alluvial deposits in terrain units Czs1/6-8 and Czs2/6-8.

Available data suggests that it is highly likely that subsoils with high salinity potential are present between Biloela and Bauhinia (KP 175 to KP 300) (GHD, 2009).

The distribution of saline soil associated terrain units within the Mainland GTP RoW is shown on Figure 7.6

Erosion

Erosion is the detachment and movement of soil or rock by water, wind or other factors such as ice and gravitational creep (SSSA, 1984). Whilst erosion is a natural process, man-made disturbances can result in accelerated erosion and cause rapid detrimental effects to the environment resulting in rapid deterioration of soil profile structure, stability and physical and chemical conditions.

The erosion potential due to construction activities in the Mainland GTP RoW may occur as a result of clearing and/or surface disturbance have been assessed based on the following classes:

- *Low (L)* – The combination of surface slope, run-on/run-off and soil erodibility is such that no appreciable erosion damage is anticipated
- *Moderate (M)* – Significant short term erosion is likely to occur due to the combination of slope, soil erodibility factors and extent of run-on/run-off. Erosion control can be achieved using structural works, topsoiling and re-vegetation techniques and other site specific intensive soil conservation works. Some slightly dispersive soil layers may be present in the profile
- *High (H)* – High to very high erosion/sediment losses are likely, due to the steepness of slopes, surface condition, soil texture and erodibility factors and surface runoff conditions. Intensive soil conservation works will be required to minimise the effects of erosion. Moderately high to highly dispersive soil layers are usually present within the soil profile.

The distribution of erosion potential classes and associated Terrain Units within the Mainland GTP RoW is shown in Figure 7.5.

The majority of the soils along the GTP RoW are considered to have moderate to high erosion potential. It is generally the subsoils that have higher erosion potentials than the topsoil horizons. Surface soils with high erosion potential are indicated to be present east of Dungree, Dawson Range, along sections of Arcadia Valley Road, and surrounding Beilba.

Locations of existing erosion problems, visible from review of aerial photography include:

- Dawson River escarpment (KP 29.5)
- Dawson River (KP 30)
- Clematis Creek (KP 109)

These locations may require intensive erosion control measures to be implemented.

Erosion management and mitigation techniques for the project are provided in Table 7.4, and in further detail in the Erosion and Sediment Control Plan (ESCP) (refer to Appendix A).



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 10km
- 5km

Erosion Potential

- High (H) - High to very high erosion/sediment losses are likely, due to the steepness of slopes, surface condition, soil texture and erodibility factors and surface runoff conditions.
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- Low - Moderate (L-M)
- Low (L) - The combination of surface slope, run-on/run-off and soil erodibility is such that no appreciable erosion damage is anticipated.

- Cadastral
- Rail
- Watercourse

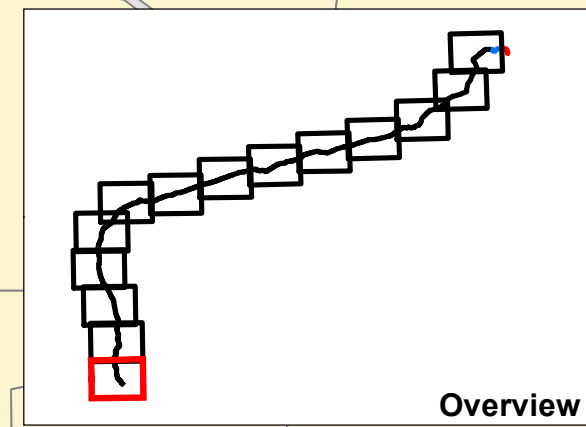
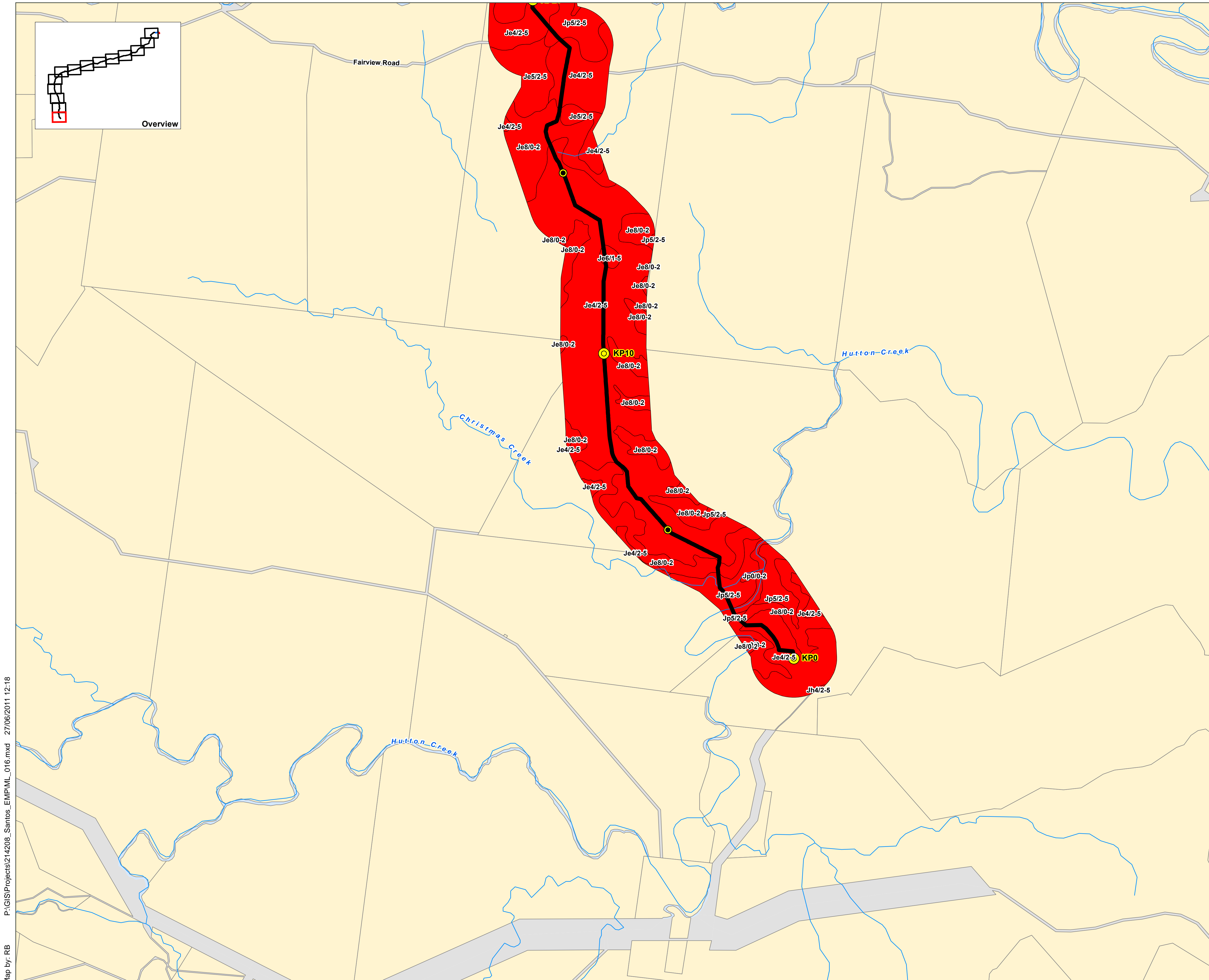
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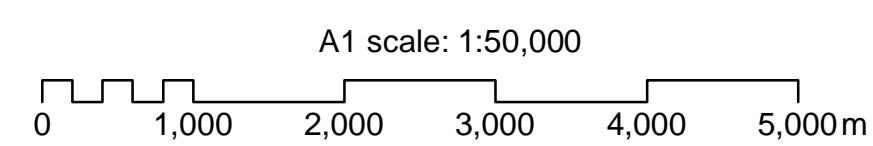
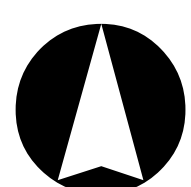
Soil Constraints: Erosion Potential Figure 7.5 (Page 1 of 14)

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Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 10km
- 5km

Erosion Potential

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- Cadastre
- Rail
- Watercourse

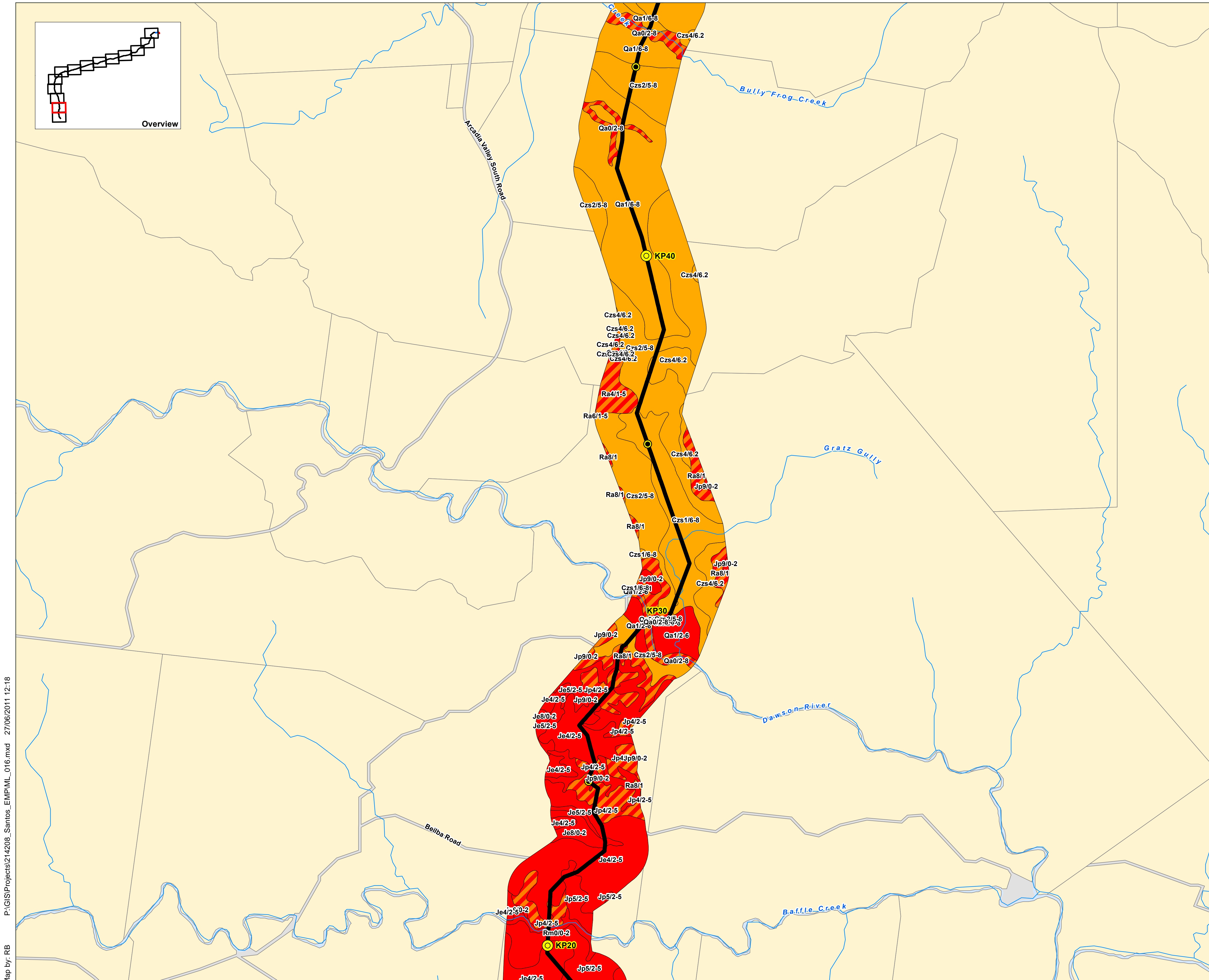
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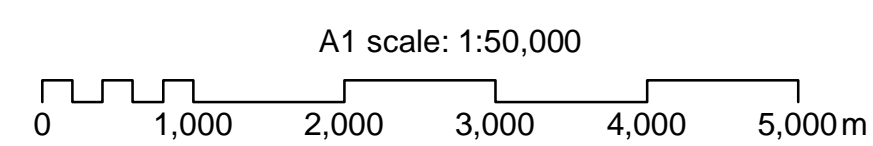
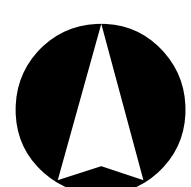
Soil Constraints: Erosion Potential Figure 7.5 (Page 2 of 14)

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Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

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- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 10km
- 5km

Erosion Potential

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- Cadastral
- Rail
- Watercourse

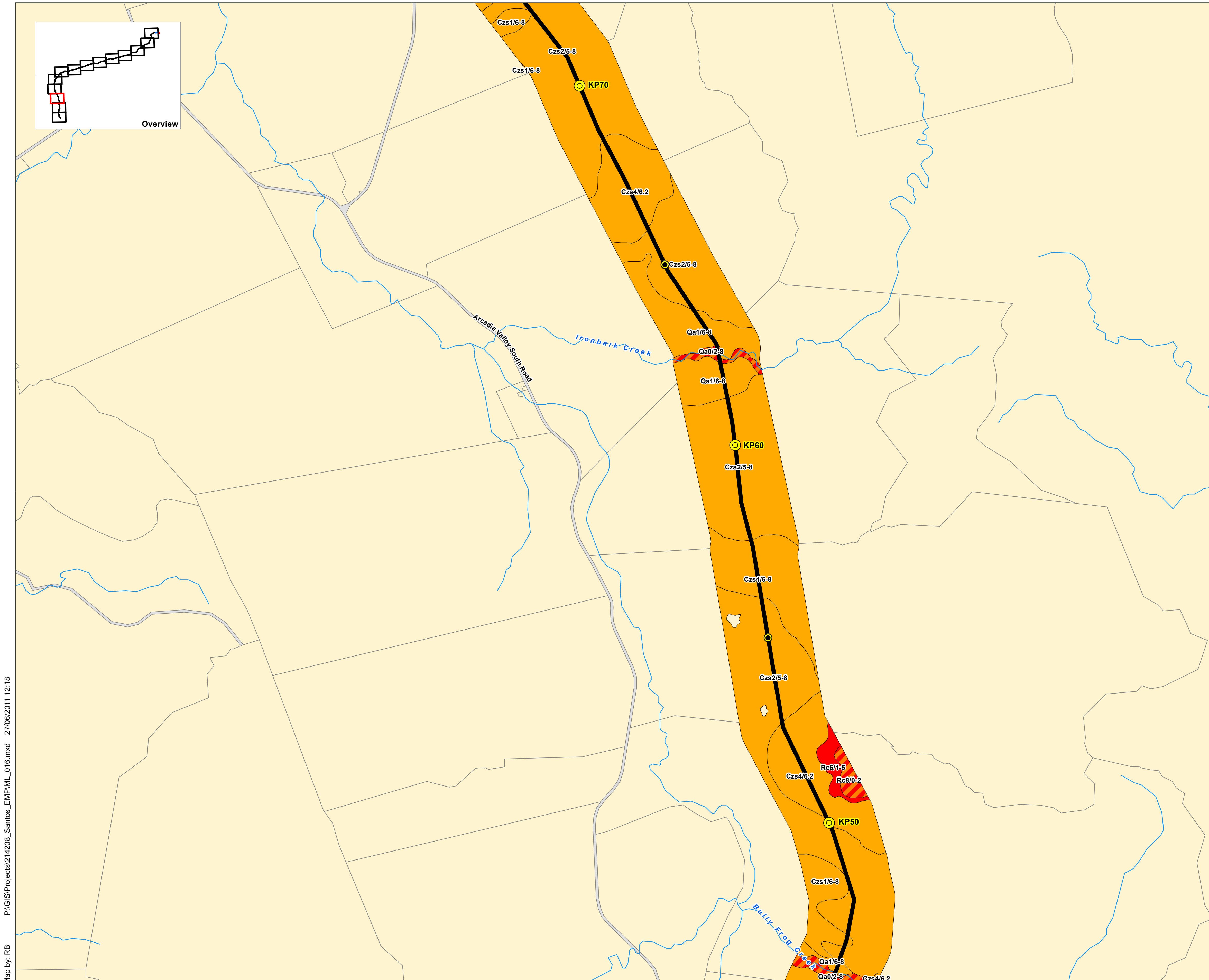
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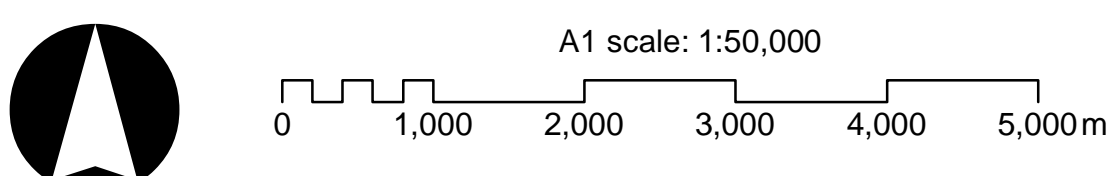
Soil Constraints: Erosion Potential Figure 7.5 (Page 3 of 14)

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Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

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Kilometre Post Distance Marker

- 10km
- 5km

Erosion Potential

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Cadastre

Rail

Watercourse

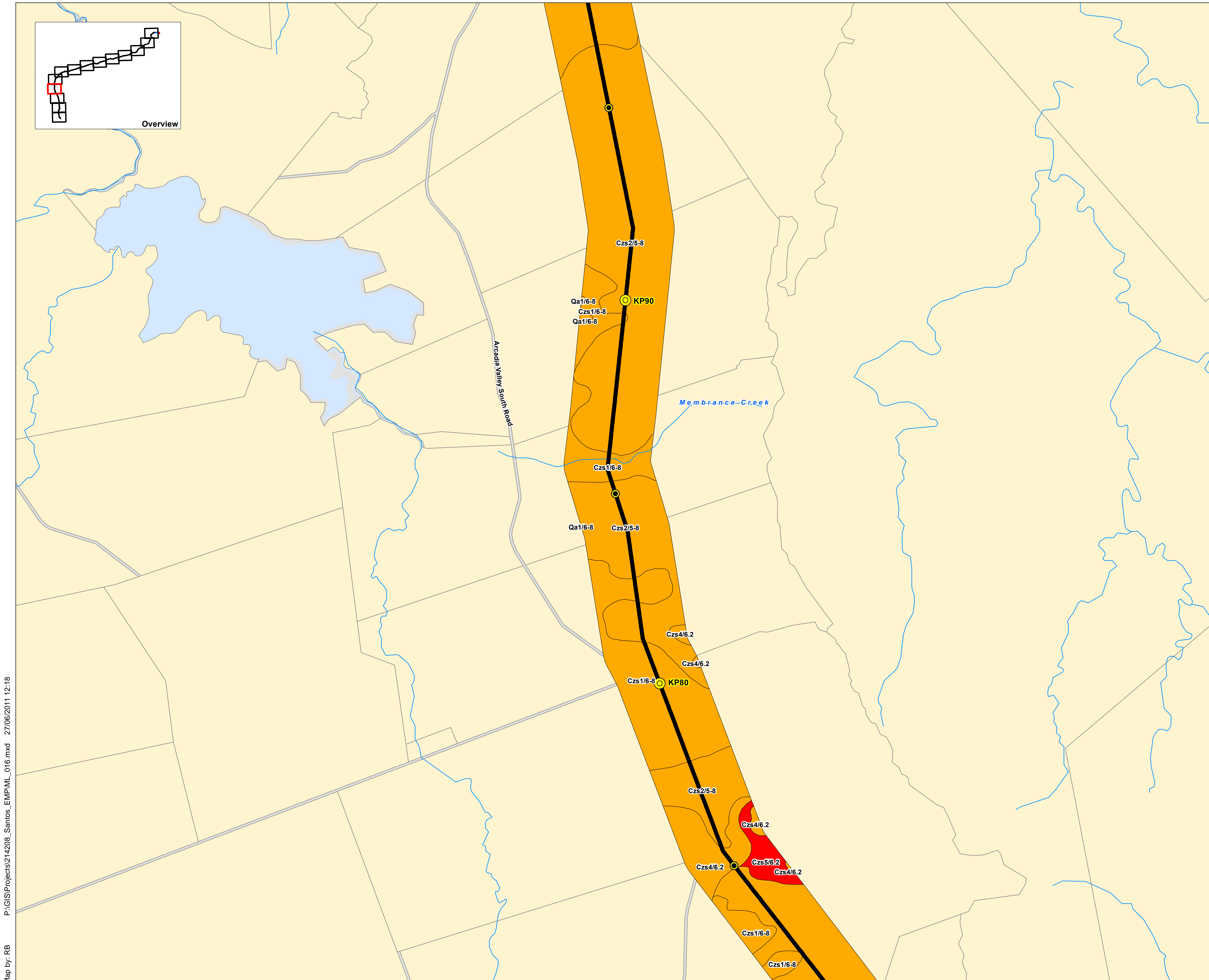
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Soil Constraints: Erosion Potential Figure 7.5 (Page 4 of 14)

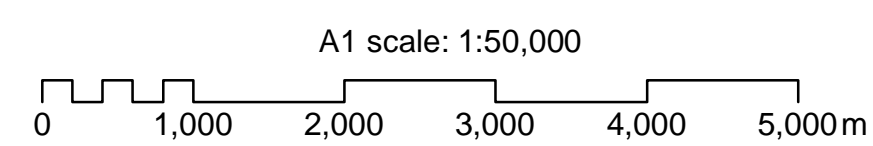
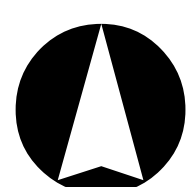
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Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

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- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 10km
- 5km

Erosion Potential

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Cadastre

Rail

Watercourse

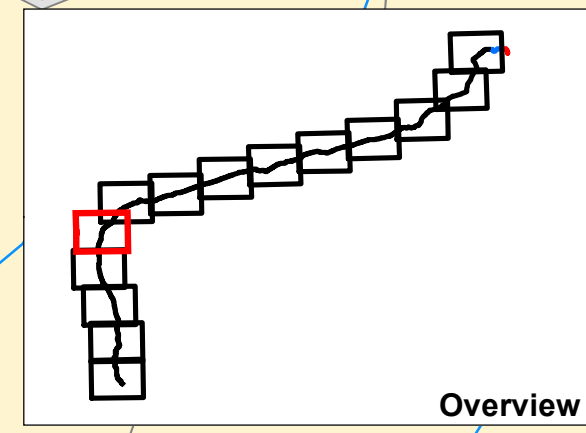
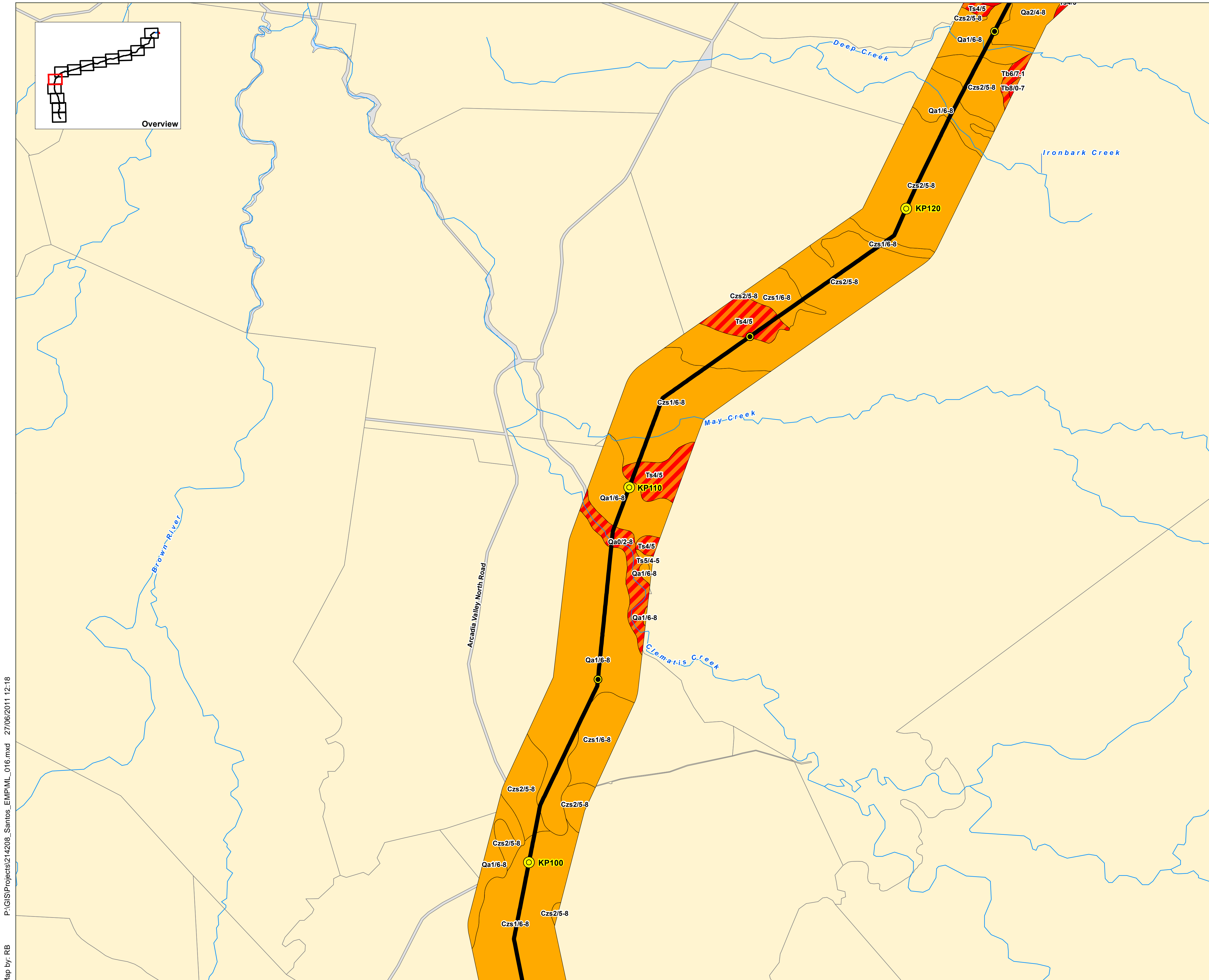
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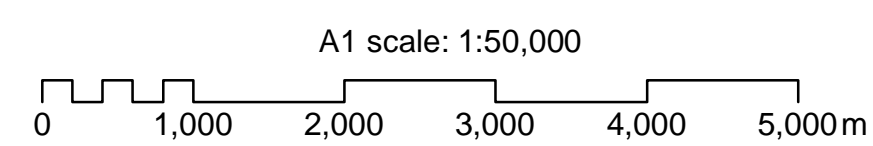
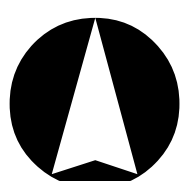
Soil Constraints: Erosion Potential Figure 7.5 (Page 5 of 14)

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Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

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- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 10km
- 5km

Erosion Potential

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- Cadastre
- Rail
- Watercourse

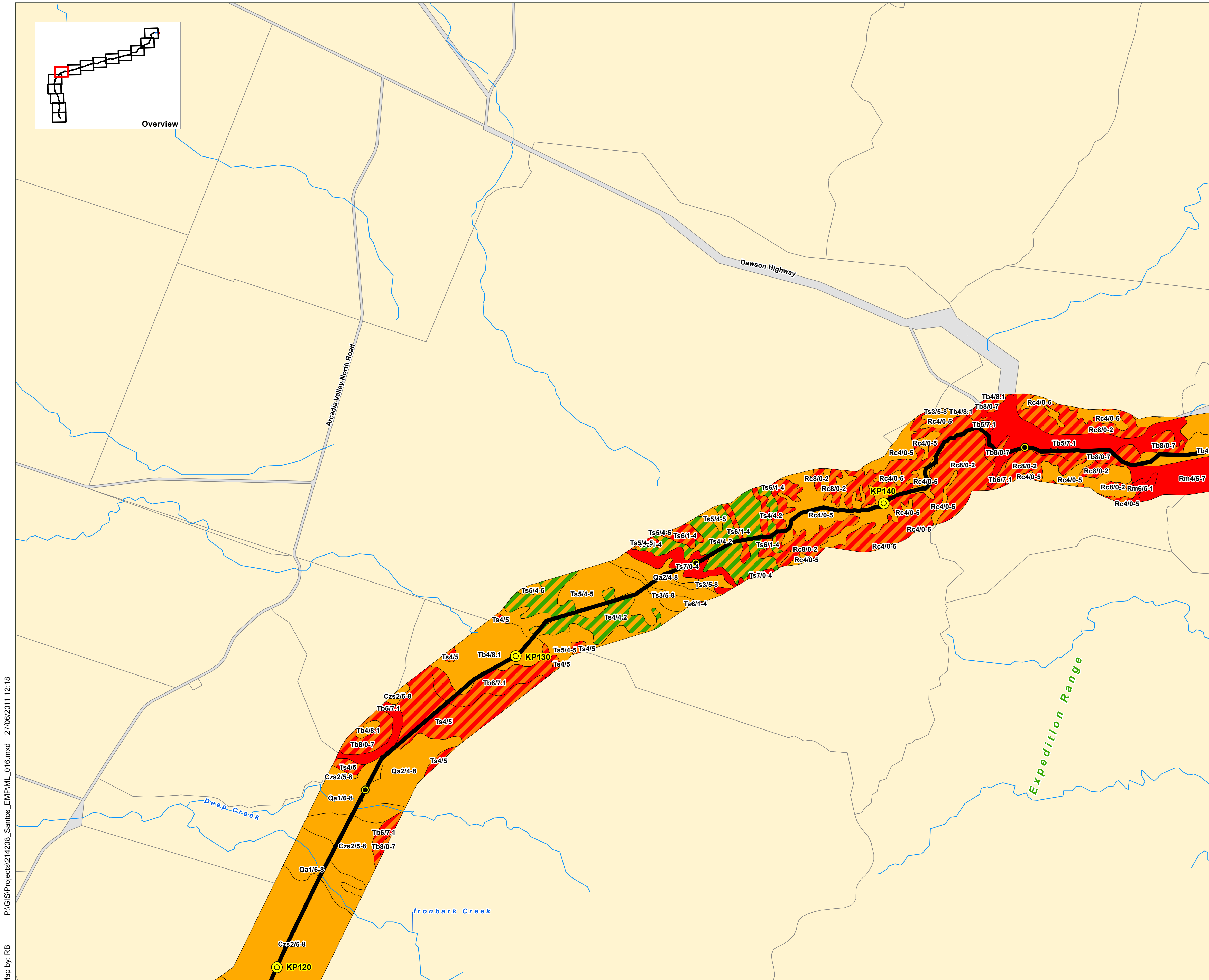
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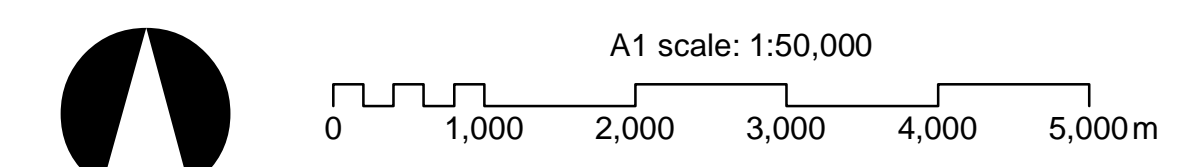
Soil Constraints: Erosion Potential Figure 7.5 (Page 6 of 14)

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Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

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- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 10km
- 5km

Erosion Potential

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- Cadastre
- Rail
- Watercourse

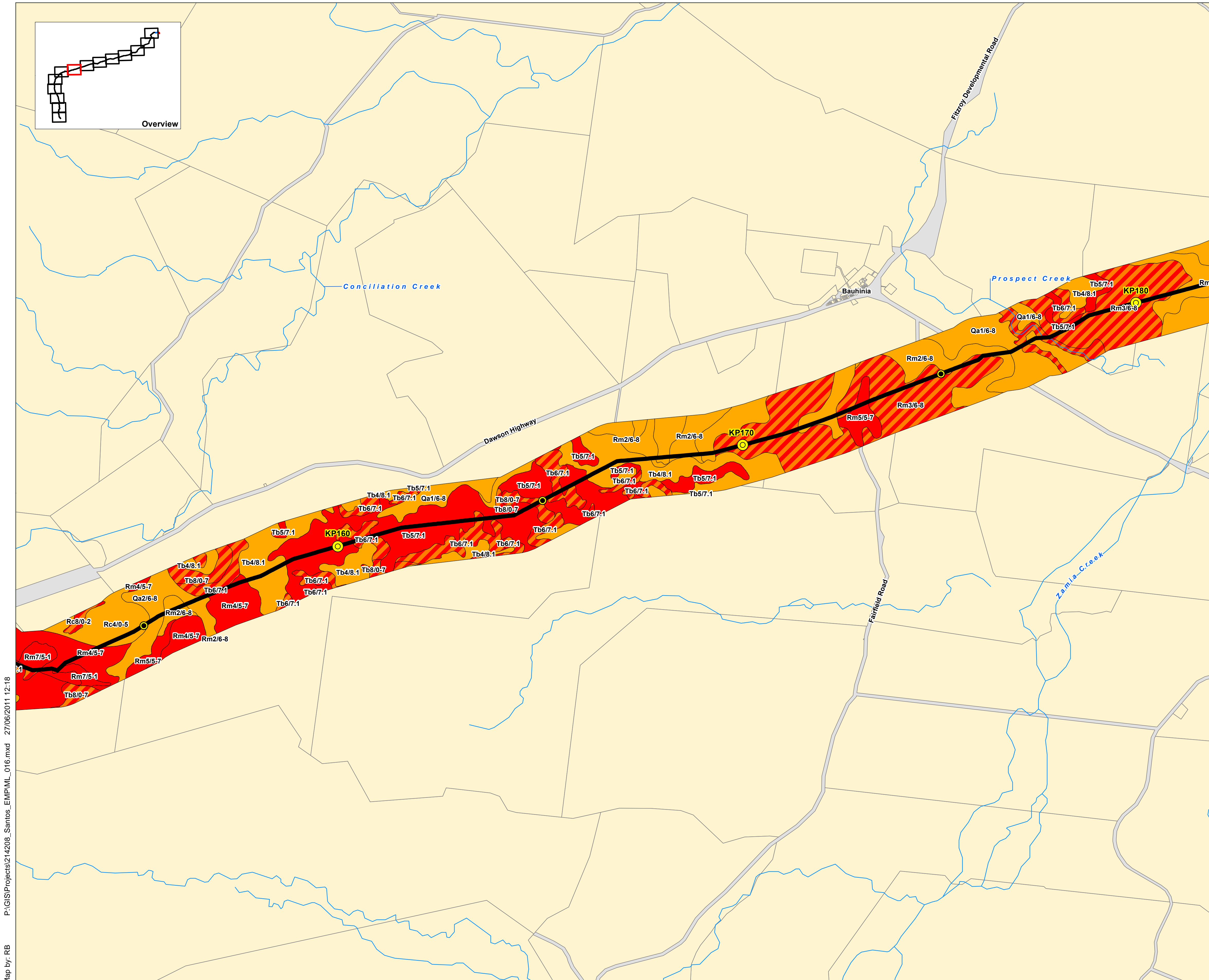
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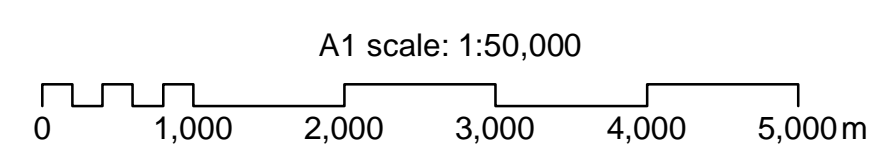
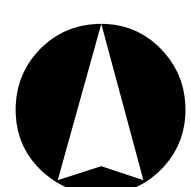
Soil Constraints: Erosion Potential Figure 7.5 (Page 7 of 14)

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Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 10km
- 5km

Erosion Potential

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Cadastre

Rail

Watercourse

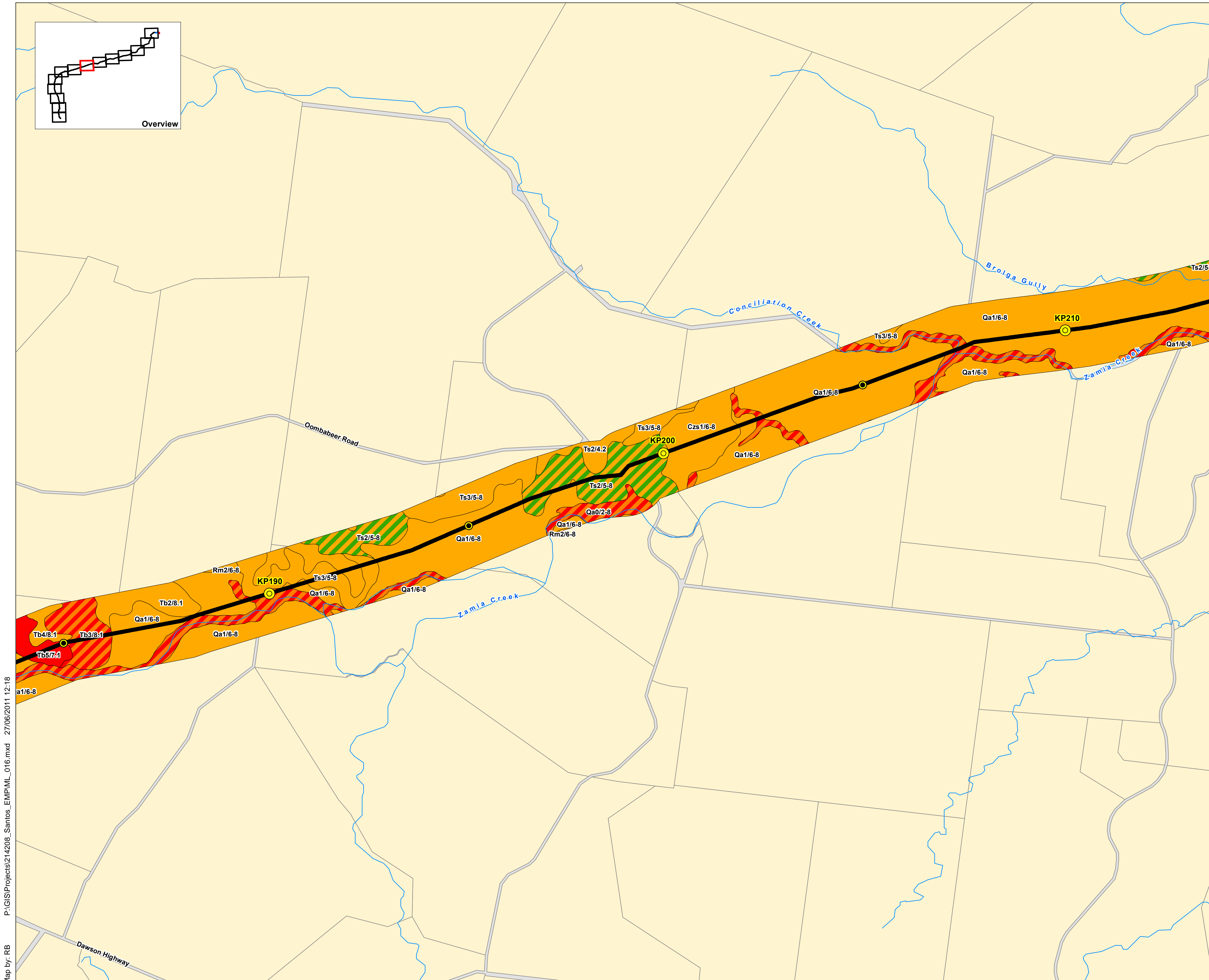
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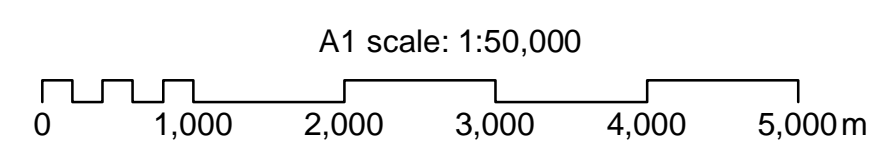
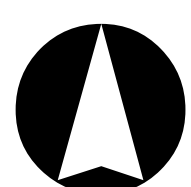
Soil Constraints: Erosion Potential Figure 7.5 (Page 8 of 14)

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Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

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- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 10km
- 5km

Erosion Potential

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- Cadastre
- Rail
- Watercourse

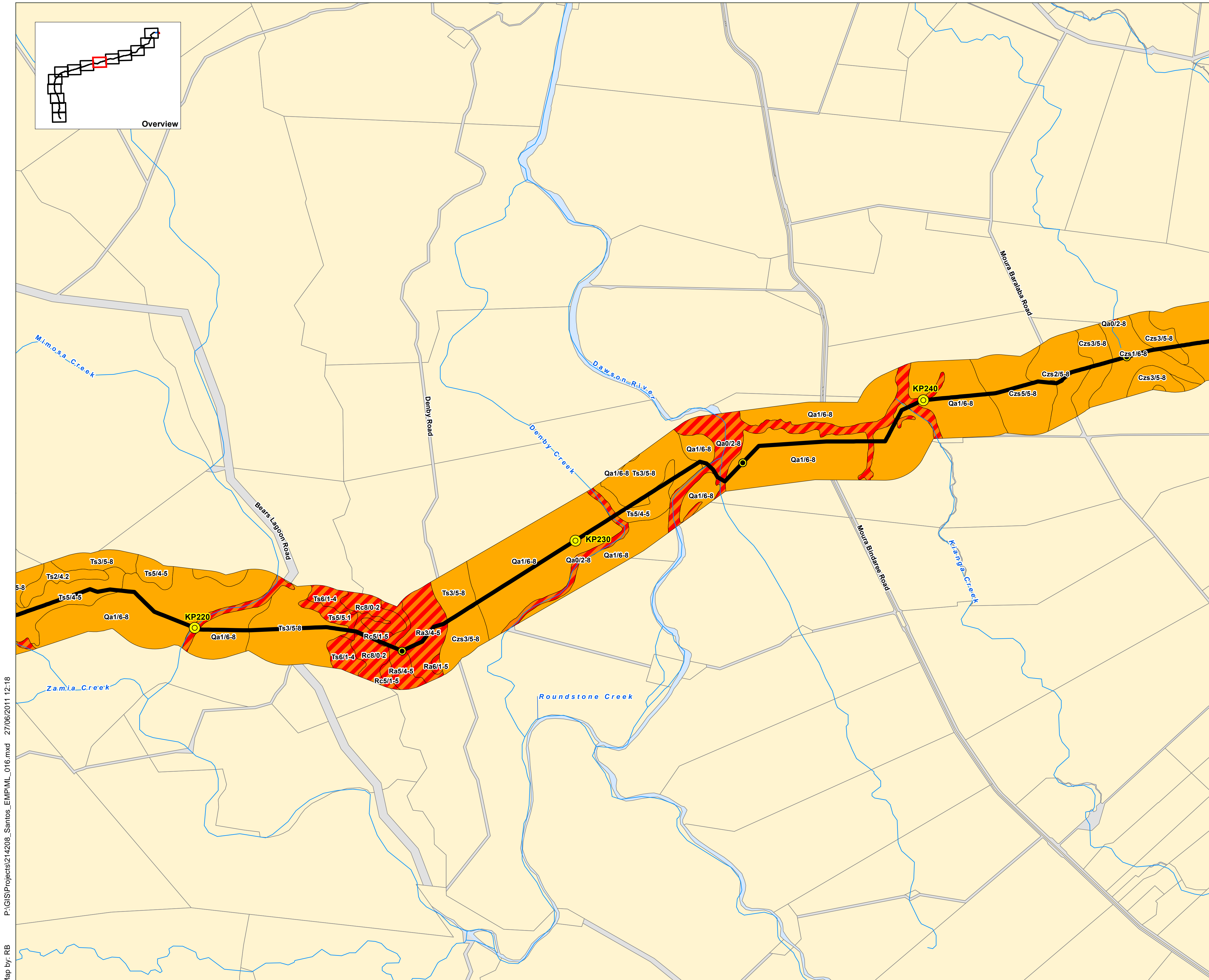
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Soil Constraints: Erosion Potential Figure 7.5 (Page 9 of 14)

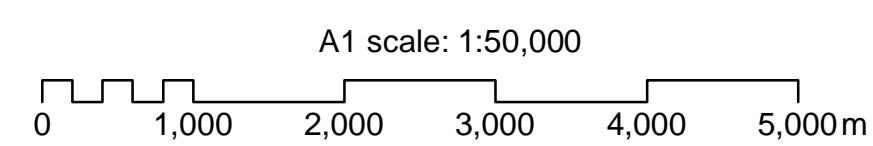
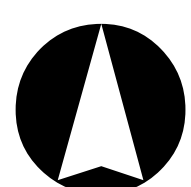
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Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
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- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 10km
- 5km

Erosion Potential

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- Cadastre
- Rail
- Watercourse

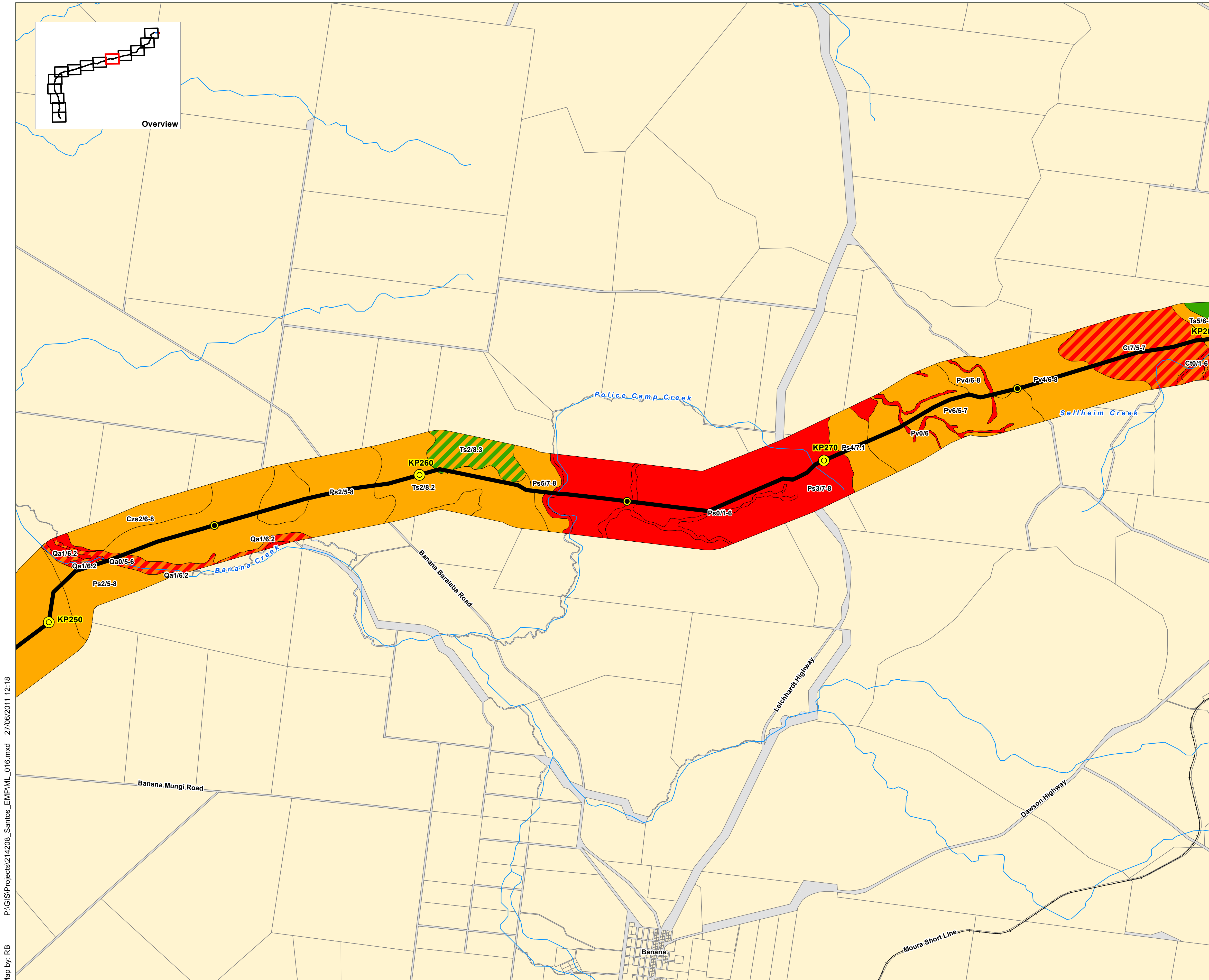
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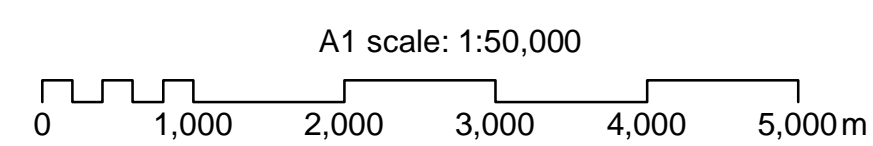
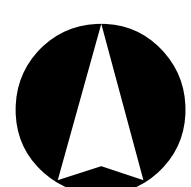
Soil Constraints: Erosion Potential Figure 7.5 (Page 10 of 14)

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Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

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Kilometre Post Distance Marker

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- 5km

Erosion Potential

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Cadastre

Rail

Watercourse

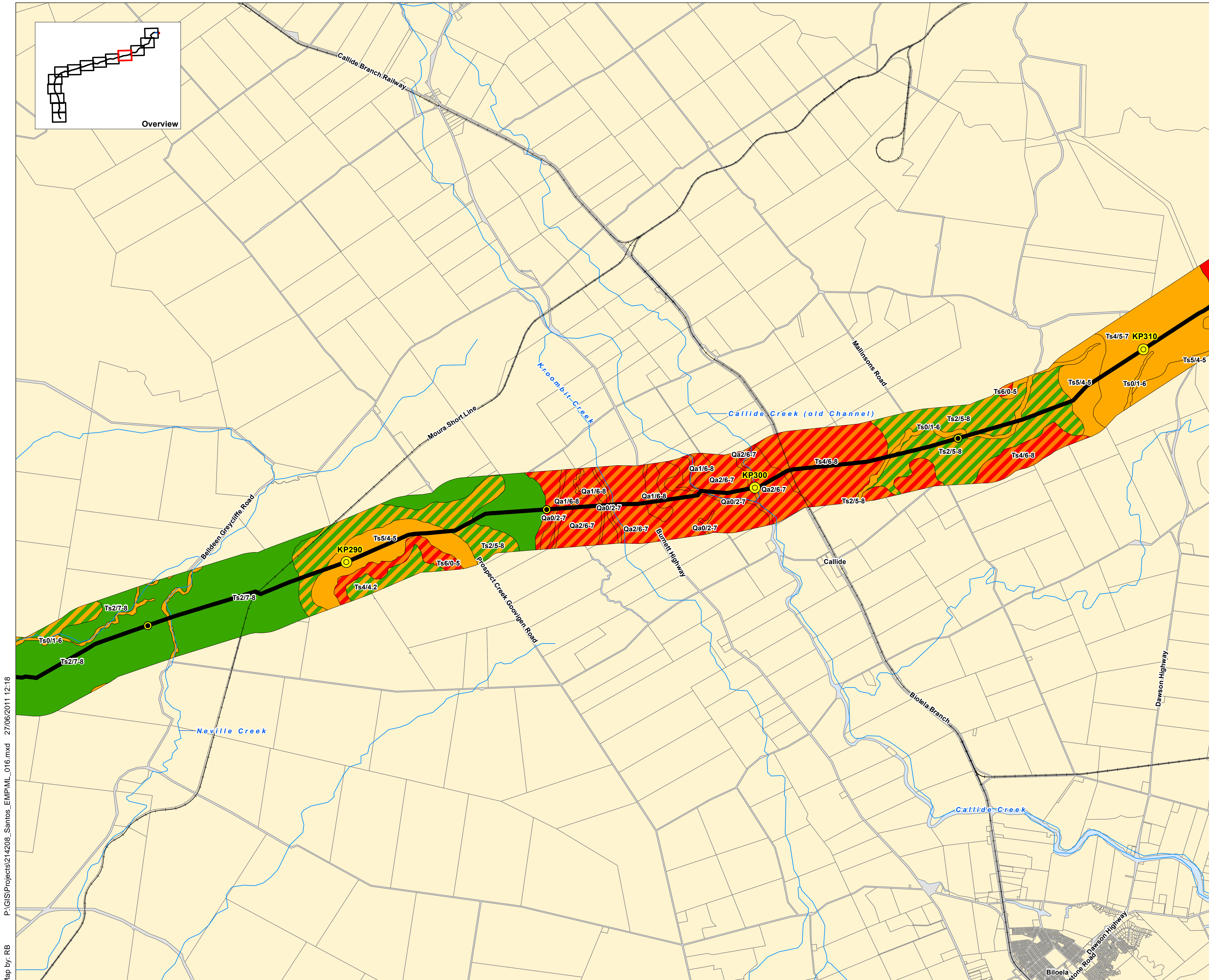
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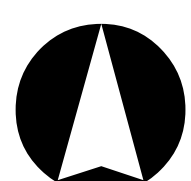
Soil Constraints: Erosion Potential Figure 7.5 (Page 11 of 14)

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Coordinate system: GCS_GDA_1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 10km
- 5km

Erosion Potential

- High (H) - High to very high erosion/sediment losses are likely, due to the steepness of slopes, surface condition, soil texture and erodibility factors and surface runoff conditions.
- Moderate - High (M-H)
- Moderate (M) - Significant short term erosion is likely to occur due to the combination of slope, soil erodibility factors and extent of run-on/run-off.
- Low - Moderate (L-M)
- Low (L) - The combination of surface slope, run-on/run-off and soil erodibility is such that no appreciable erosion damage is anticipated.

- Cadastre
- Rail
- Watercourse

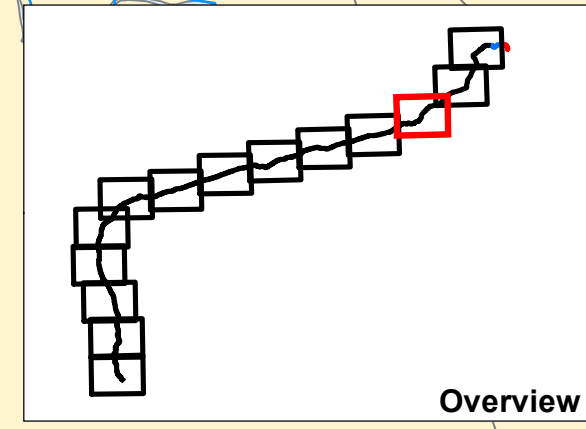
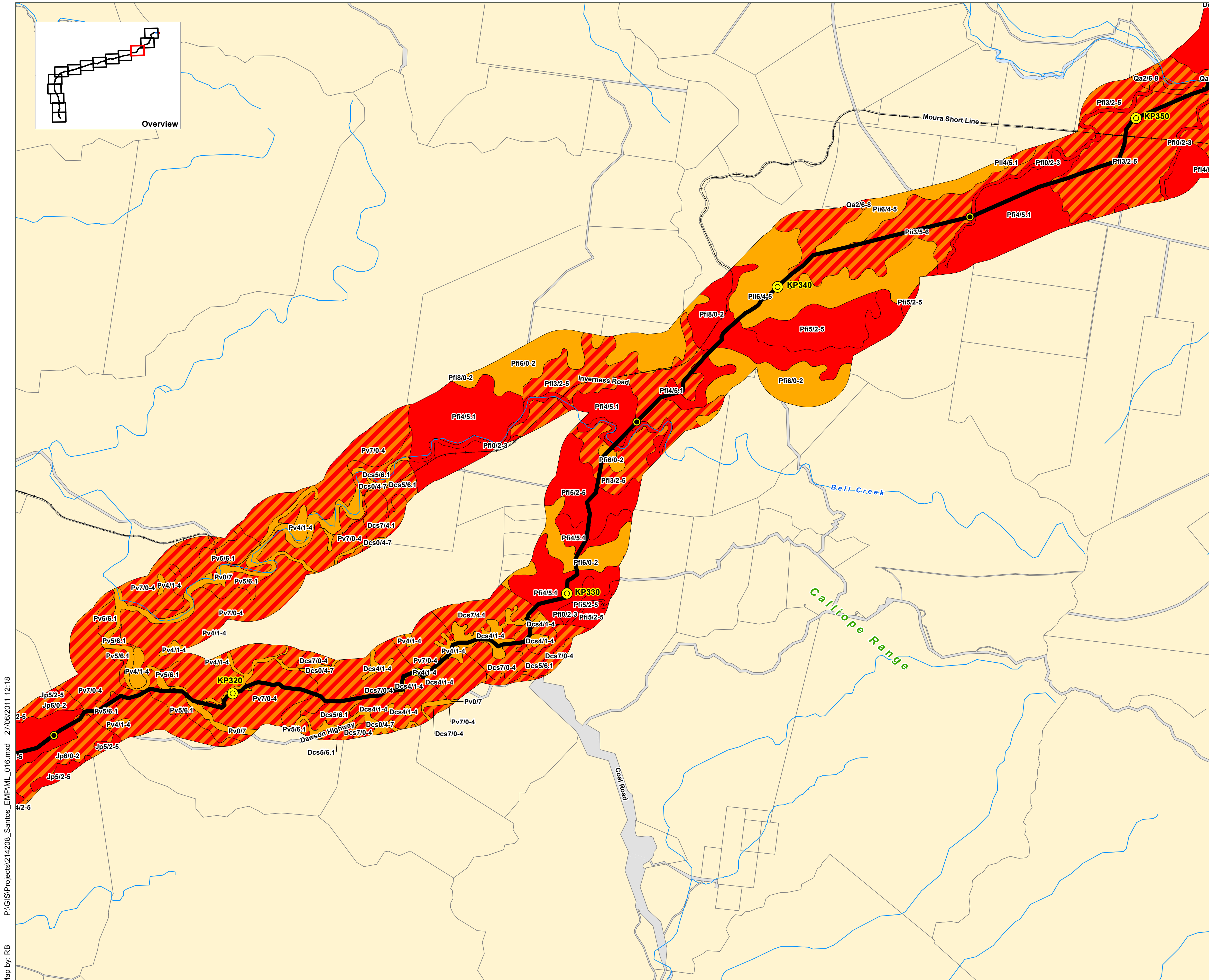
Note: All figures should be reviewed in conjunction with Table 7.1 "Generic Key to the identification of Terrain Units", URS 2009.

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Cadastre: Department of Management and Resource Management, Jun 2011.
GLNG Terrain Units: Supplementary EIS, URS, 2009.

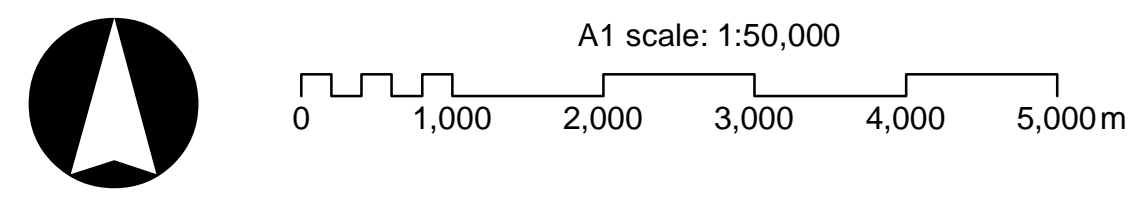
Soil Constraints: Erosion Potential Figure 7.5 (Page 12 of 14)

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GLNG No: 3381-40-0409
Coordinate system: GCS_GDA_1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 10km
- 5km

Erosion Potential

- High (H) - High to very high erosion/sediment losses are likely, due to the steepness of slopes, surface condition, soil texture and erodibility factors and surface runoff conditions.
- Moderate - High (M-H)
- Moderate (M) - Significant short term erosion is likely to occur due to the combination of slope, soil erodibility factors and extent of run-on/run-off.
- Low - Moderate (L-M)
- Low (L) - The combination of surface slope, run-on/run-off and soil erodibility is such that no appreciable erosion damage is anticipated.
- Cadastre
- Rail
- Watercourse

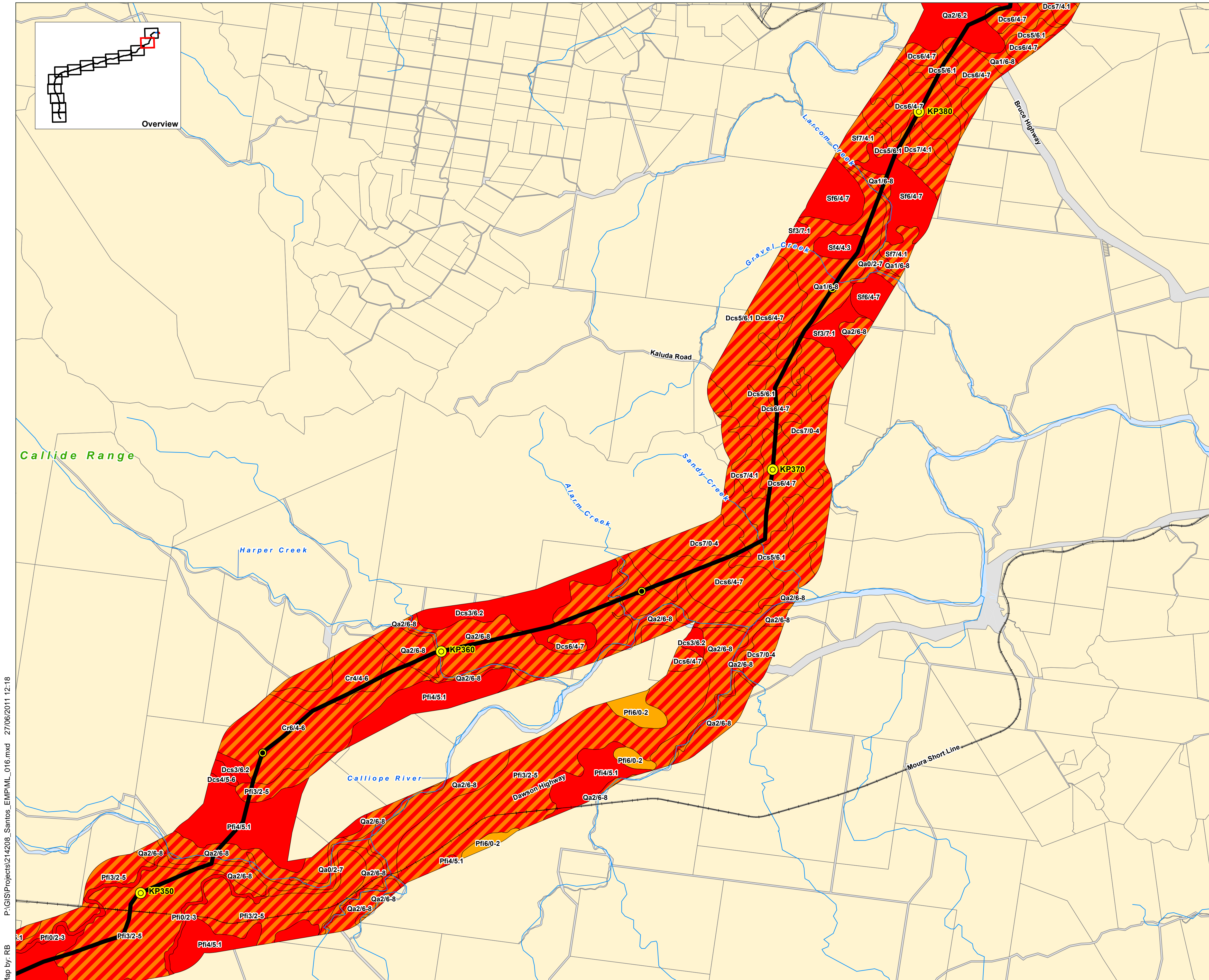
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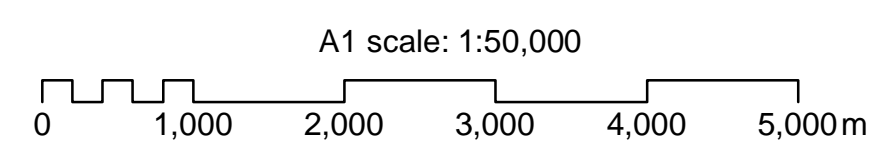
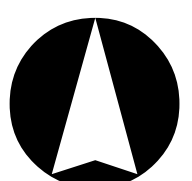
Soil Constraints: Erosion Potential Figure 7.5 (Page 13 of 14)

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GLNG No: 3381-40-0409
Coordinate system: GCS_GDA_1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 10km
- 5km

Erosion Potential

- High (H) - High to very high erosion/sediment losses are likely, due to the steepness of slopes, surface condition, soil texture and erodibility factors and surface runoff conditions.
- Moderate - High (M-H)
- Moderate (M) - Significant short term erosion is likely to occur due to the combination of slope, soil erodibility factors and extent of run-on/run-off.
- Low - Moderate (L-M)
- Low (L) - The combination of surface slope, run-on/run-off and soil erodibility is such that no appreciable erosion damage is anticipated.
- Cadastre
- Rail
- Watercourse

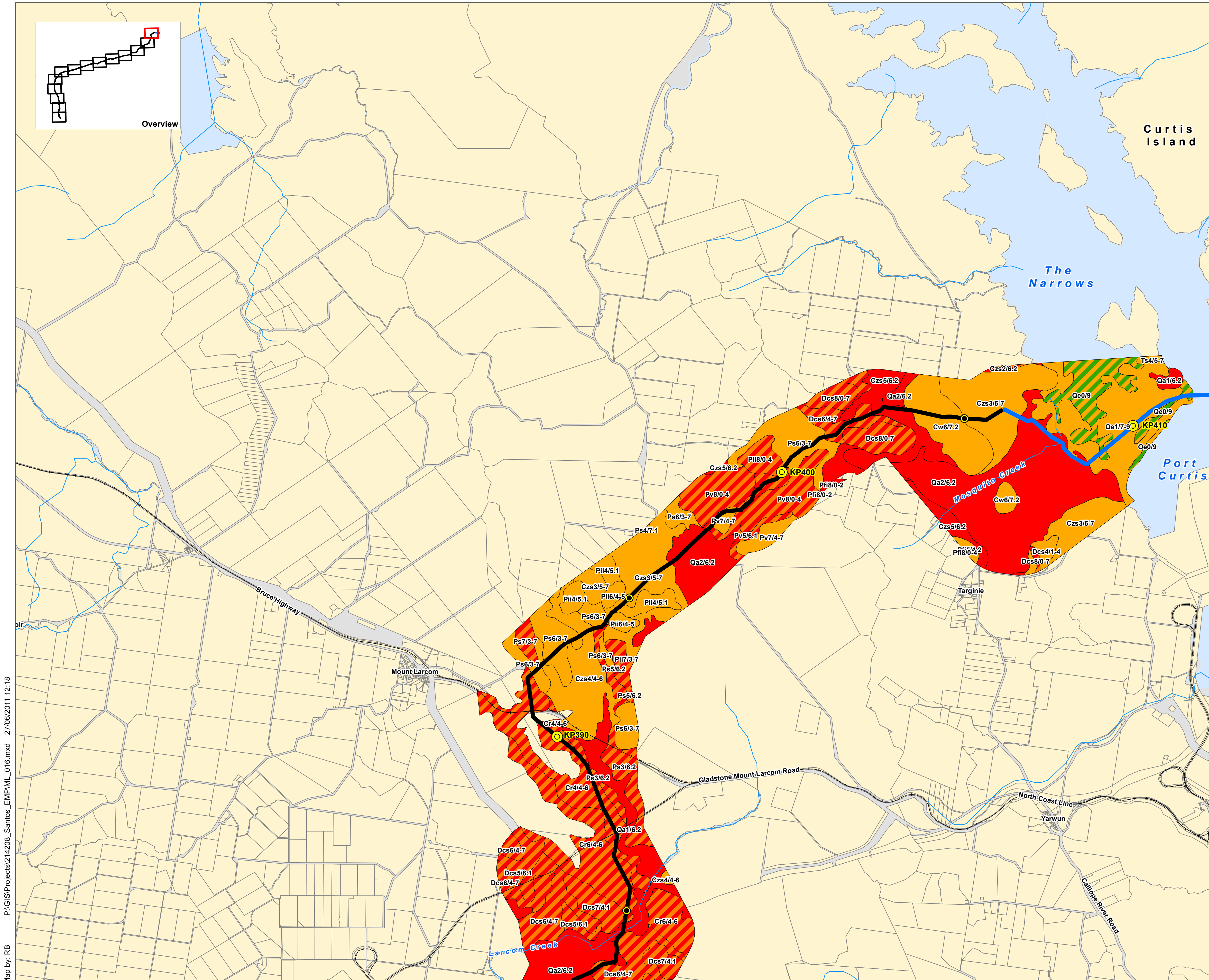
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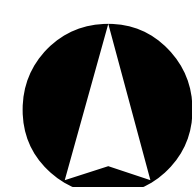
Soil Constraints: Erosion Potential Figure 7.5 (Page 14 of 14)

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Coordinate system: GCS_GDA_1994

7.3.8 Sodicity

Sodicity is the level of exchangeable sodium in the soil. It is determined using the Exchangeable Sodium Percentage (ESP), which is the amount of exchangeable sodium expressed as a percentage of the CEC. Sodic soils are susceptible to structural degradation on exposure and tend to exhibit the following general problems:

- Severe surface crusting
- Likely dispersion on wetting
- Very low infiltration and hydraulic conductivity
- Very hard dense subsoils
- High susceptibility to severe gully erosion if exposed and unprotected
- High susceptibility to tunnel erosion

Sodicity in the Mainland GTP RoW has been rated based on ESP (taken from Northcote & Skene (1972)) as follows:

- *Negligible* – very low or non Sodic, ESP < 6%
- *Rating 1* – Sodic, ESP 6-14%
- *Rating 2* – Strongly sodic, ESP > 14%
- *Rating 3* – Very strongly sodic, ESP > 25%

Sodic and locally strongly sodic soil profiles tend to occur mainly in the subsoil and deeper soil horizons of Soil Group 6, to a lesser extent in Soil Group 5 and mainly in the deeper subsoils of Soil Groups 7 and 8. Soils with medium to high levels of exchangeable sodium generally tend to pre-disperse the material to dispersion. As a result these soils may become subject to rill and/or gully erosion if disturbed or exposed and left unprotected from the effects of rainfall or surface water infiltration.

Figure 7.6 illustrates problem soils along the GTP, and where sodicity is identified as a problem the associated terrain unit is identified accordingly.

Sodic soils are indicated along the majority of the Mainland GTP RoW with the main exceptions being the soils of the Calliope, Callide and Dawson Ranges. Of these sodic soils the subsoils are considered strongly sodic, whilst the topsoil tends to have very low sodicity (GHD, 2009)

7.3.9 Reactive soils

Reactive soils are known to occur along the Mainland GTP RoW. These soils exhibit substantial shrink/swell characteristics due to wetting and drying cycles which may result in damage to structures, foundations and buried services (including pipelines) due to differential ground movements.

Soil reactivity in the Mainland GTP RoW has been rated based on the following criteria:

- *Low* – Nil or low reactivity, predominately sandy coarse-textured soils with Kaolin clay minerals where present
- *R1* – Moderately reactive soil, (eg soils which have medium to heavy clay subsoils), but are not subject to substantial soil swelling or shrinkage; mainly illite clay minerals present
- *R2* – Shallow or medium deep, highly reactive (cracking) clay soils, underlain by low or non-reactive substrate soils or weathered rock
- *R3* – Deep, highly reactive (cracking) clay soils subject to substantial swelling and shrinkage on wetting and drying; mainly smectite clay minerals present



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 10km
- 5km

Cadastre

- Rail
- Watercourse

Problem Soils

- High
- Moderate - High
- Moderate
- Low - Moderate
- Low

Description:

R

Soil Reactivity

- L - Nil or low soil
- R1 - Moderately reactive soils
- R2 - Shallow or medium deep, highly reactive (cracking) clay soils
- R3 - Deep, highly reactive (cracking) clay soils

Sa

Soil Salinity

- L - Nil to Low Salinity
- M - Medium Salinity
- H - High to Very High Salinity

So

Sodicity (ESP)

- N - Very low or non Sodic, ESP <6%
- Rating 1 - Sodic, ESP 6-14%
- Rating 2 - Strongly Sodic, ESP >14-25%
- Rating 3 - Very strongly Sodic, ESP >25%

D

Dispersion Class

- N - Non-dispersive
- Sl - Slightly Dispersive
- M - Moderately Dispersive
- H - Strongly Dispersive

ASS

Acid Sulfate Soils

Note: All figures should be reviewed in conjunction with Table 7.1 "Generic Key to the identification of Terrain Units", URS 2009.

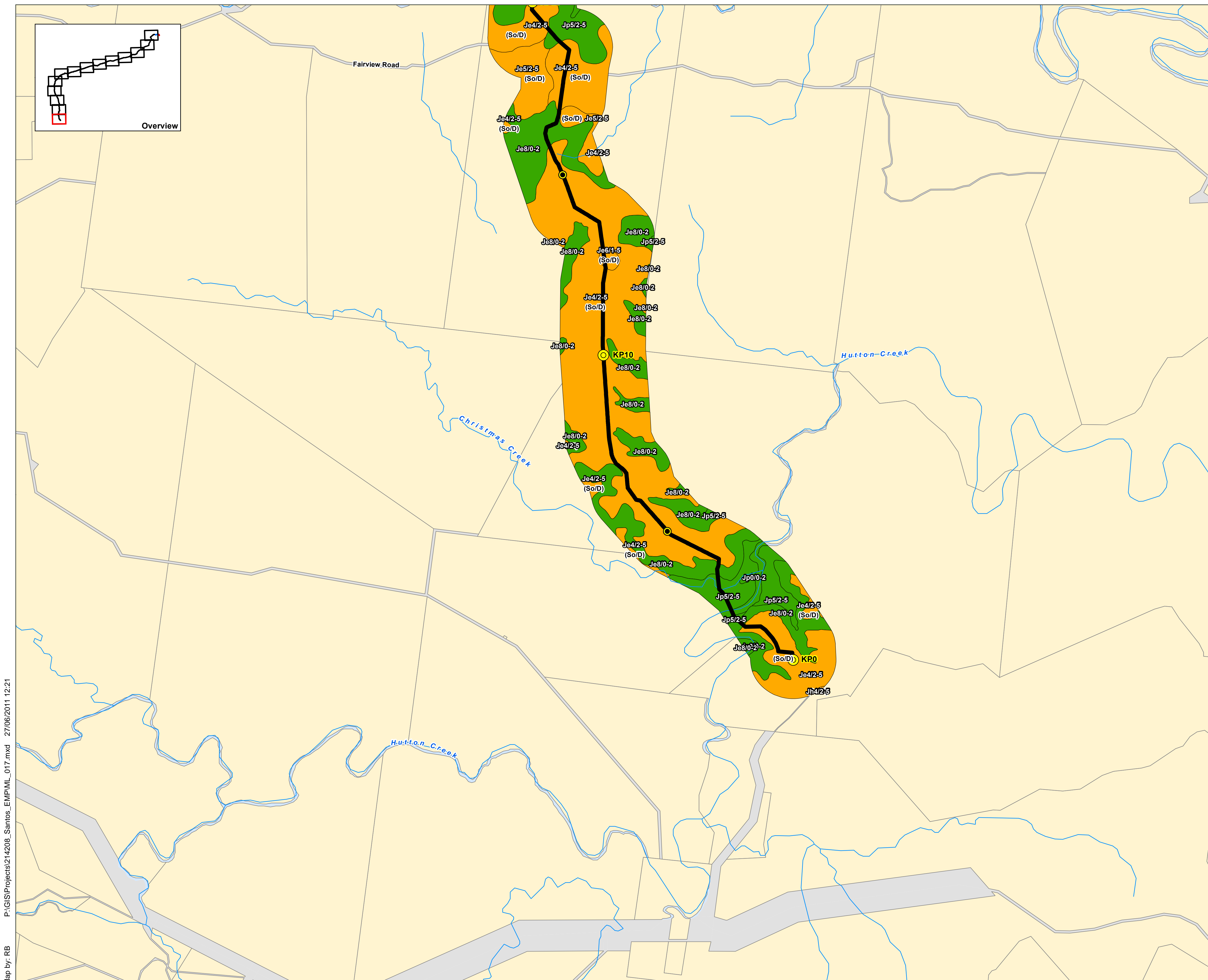
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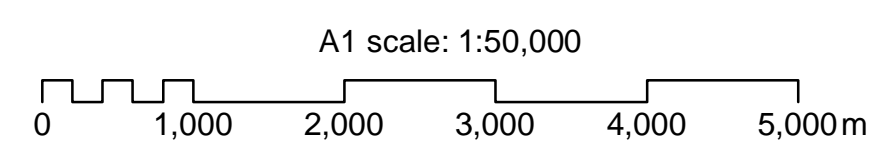
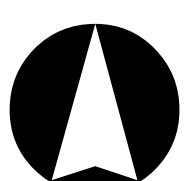
**Soil Constraints:
 Problem Soils**
Figure 7.6 (Page 1 of 14)

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Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 10km
- 5km
- Cadastre

- Rail
- Watercourse

Problem Soils

- High
- Moderate - High
- Moderate
- Low - Moderate
- Low

Description:

R

Soil Reactivity

- L - Nil or low soil
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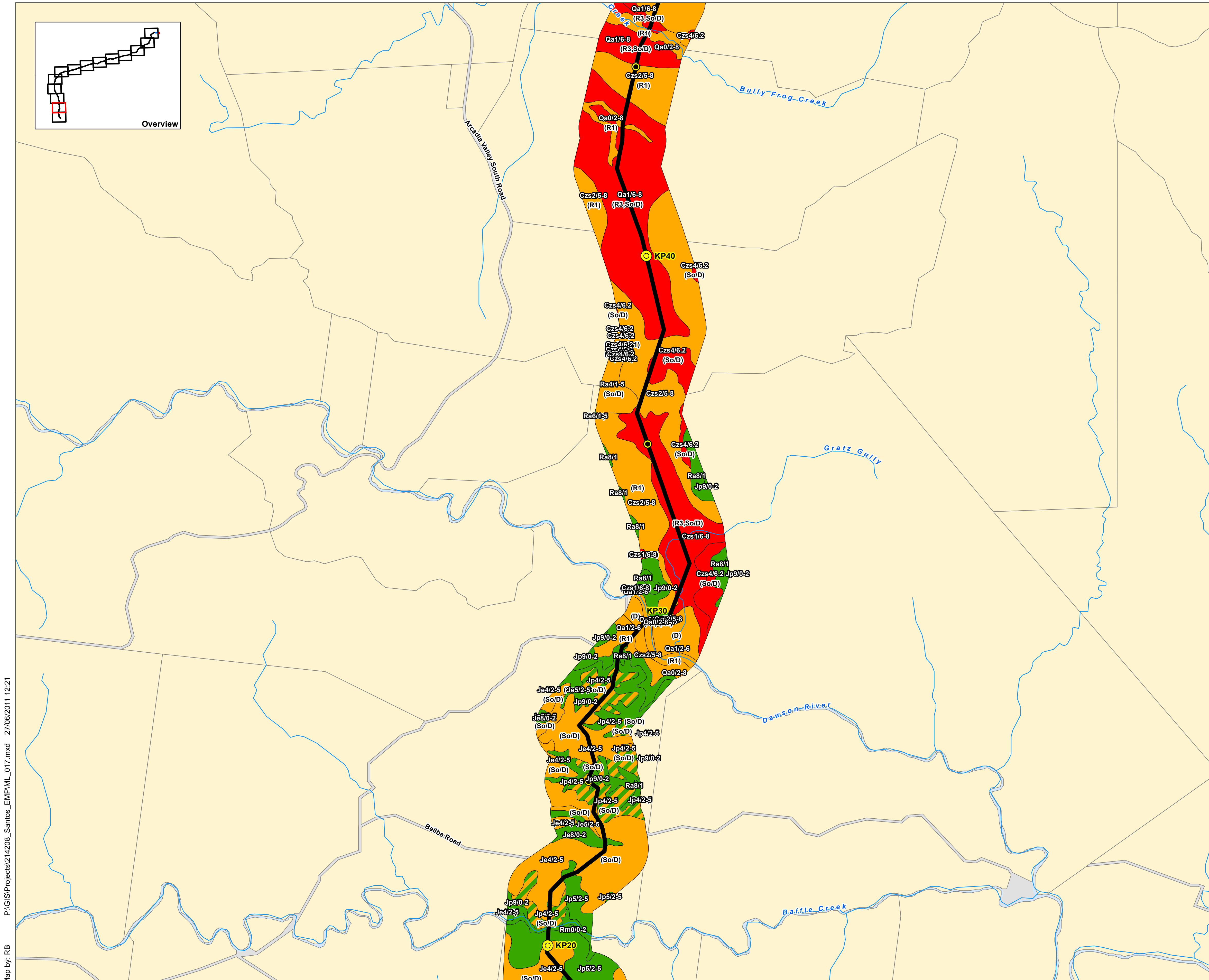
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Soil Constraints: Problem Soils Figure 7.6 (Page 2 of 14)

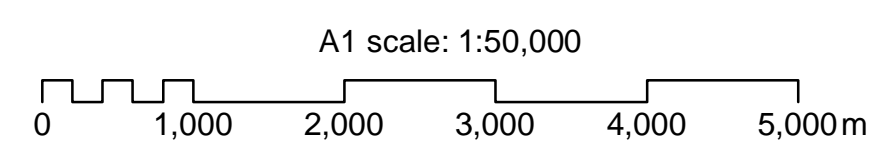
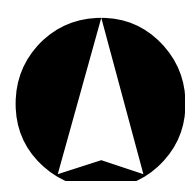
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Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 10km
- 5km

Cadastre

Rail

Watercourse

Problem Soils

- High
- Moderate - High
- Moderate
- Low - Moderate
- Low

Description:

R

Soil Reactivity

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- R1 - Moderately reactive soils
- R2 - Shallow or medium deep, highly reactive (cracking) clay soils
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Sa

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Acid Sulfate Soils

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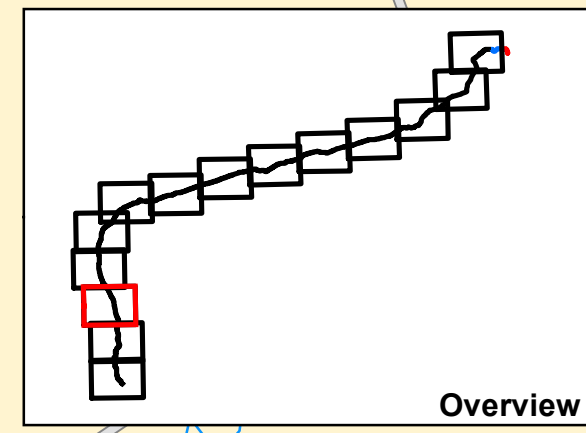
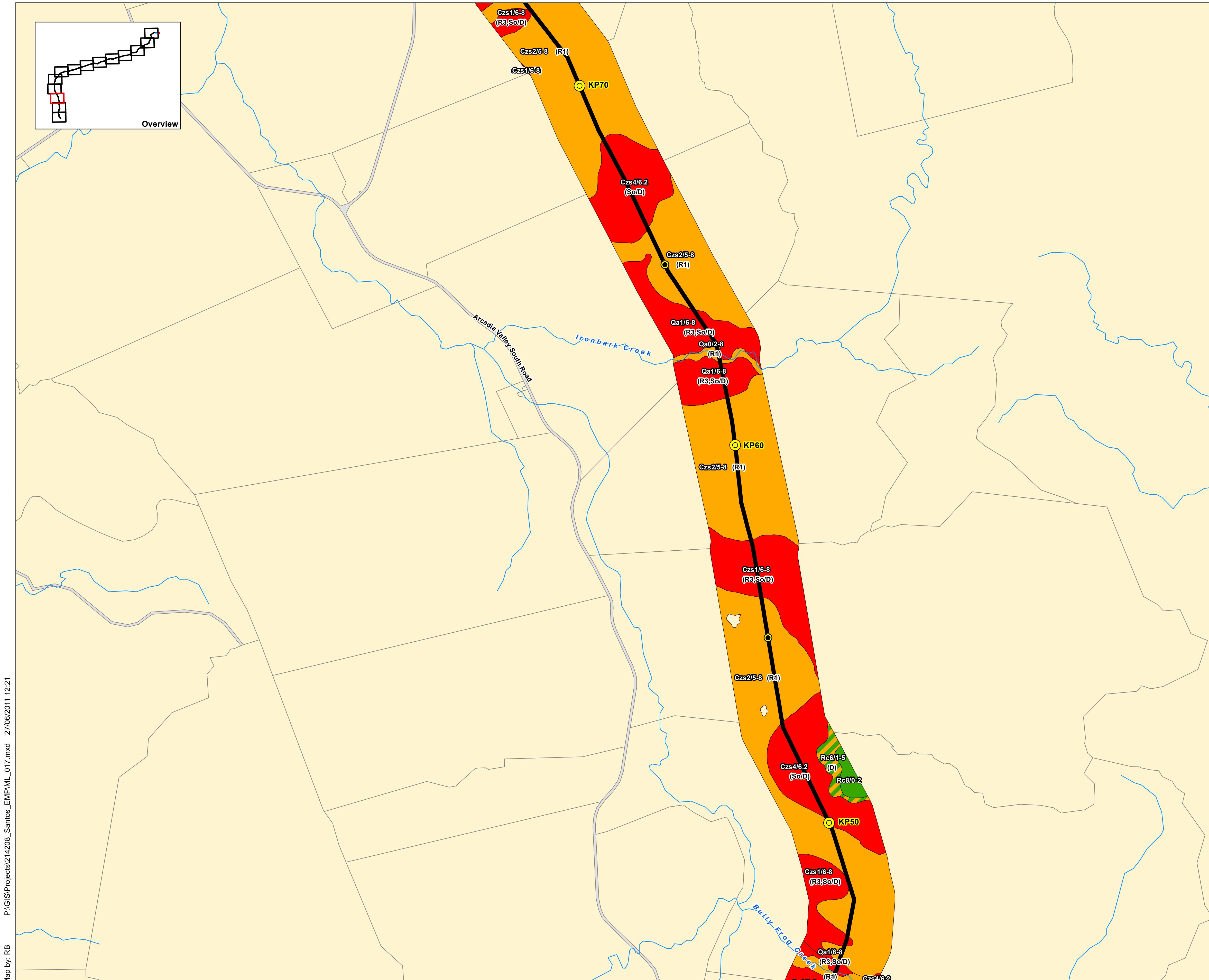
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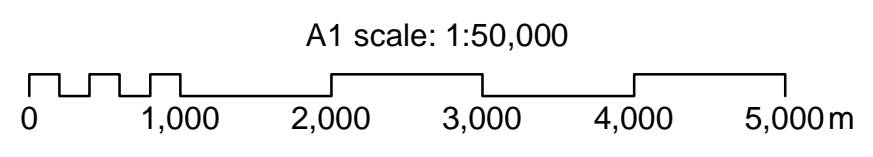
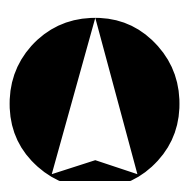
Soil Constraints: Problem Soils Figure 7.6 (Page 3 of 14)

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Coordinate system: GCS_GDA_1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 10km
- 5km

Cadastre

Rail

Watercourse

Problem Soils

- High
- Moderate - High
- Moderate
- Low - Moderate
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Description:

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Soil Reactivity

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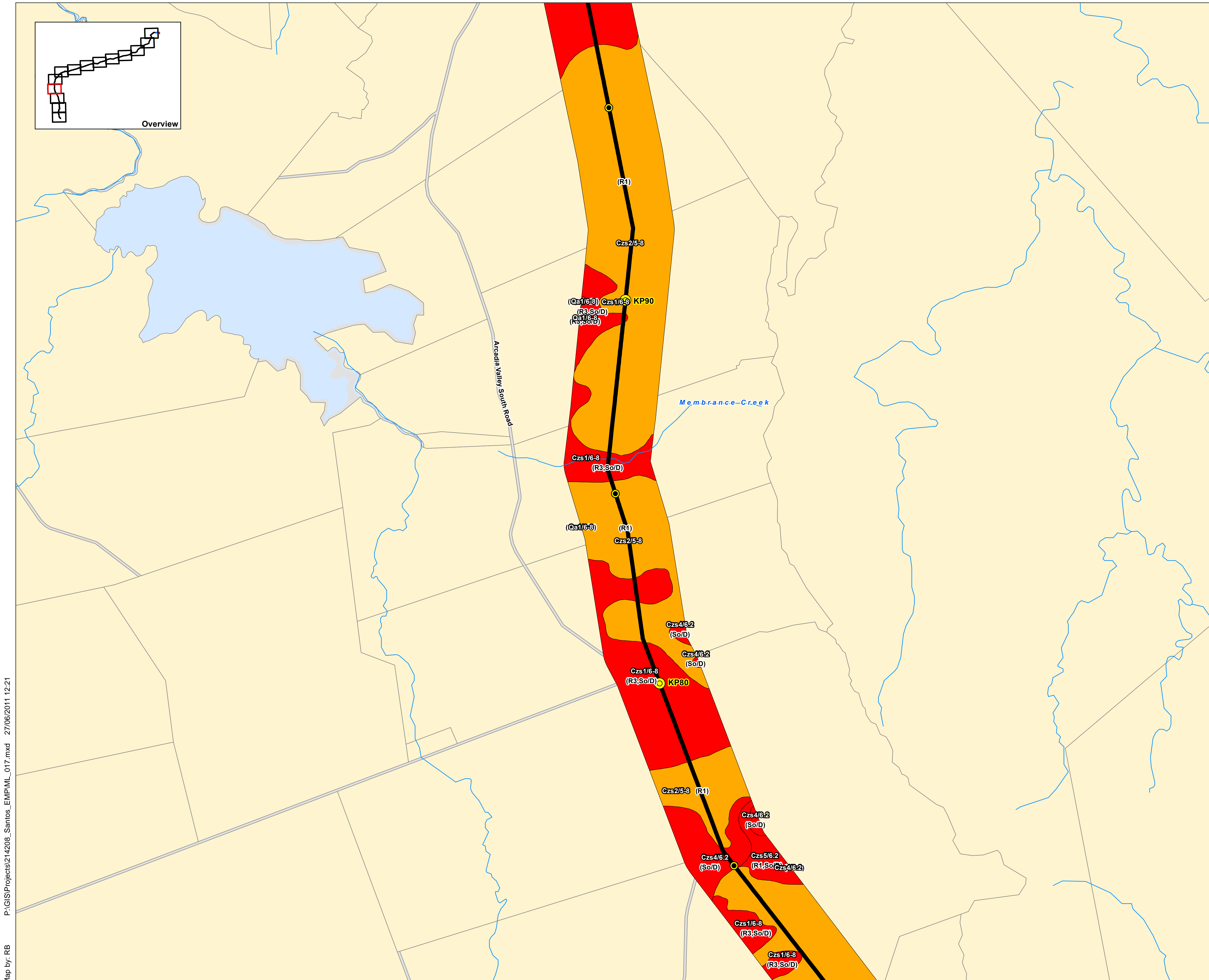
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Soil Constraints: Problem Soils Figure 7.6 (Page 4 of 14)

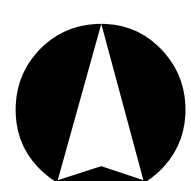
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Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 10km
- 5km

- Cadastre
- Rail
- Watercourse

Problem Soils

- High
- Moderate - High
- Moderate
- Low - Moderate
- Low

Description:

R

Soil Reactivity

- L - Nil or low soil
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- R3 - Deep, highly reactive (cracking) clay soils

Sa

Soil Salinity

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Sodicity (ESP)

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Acid Sulfate Soils

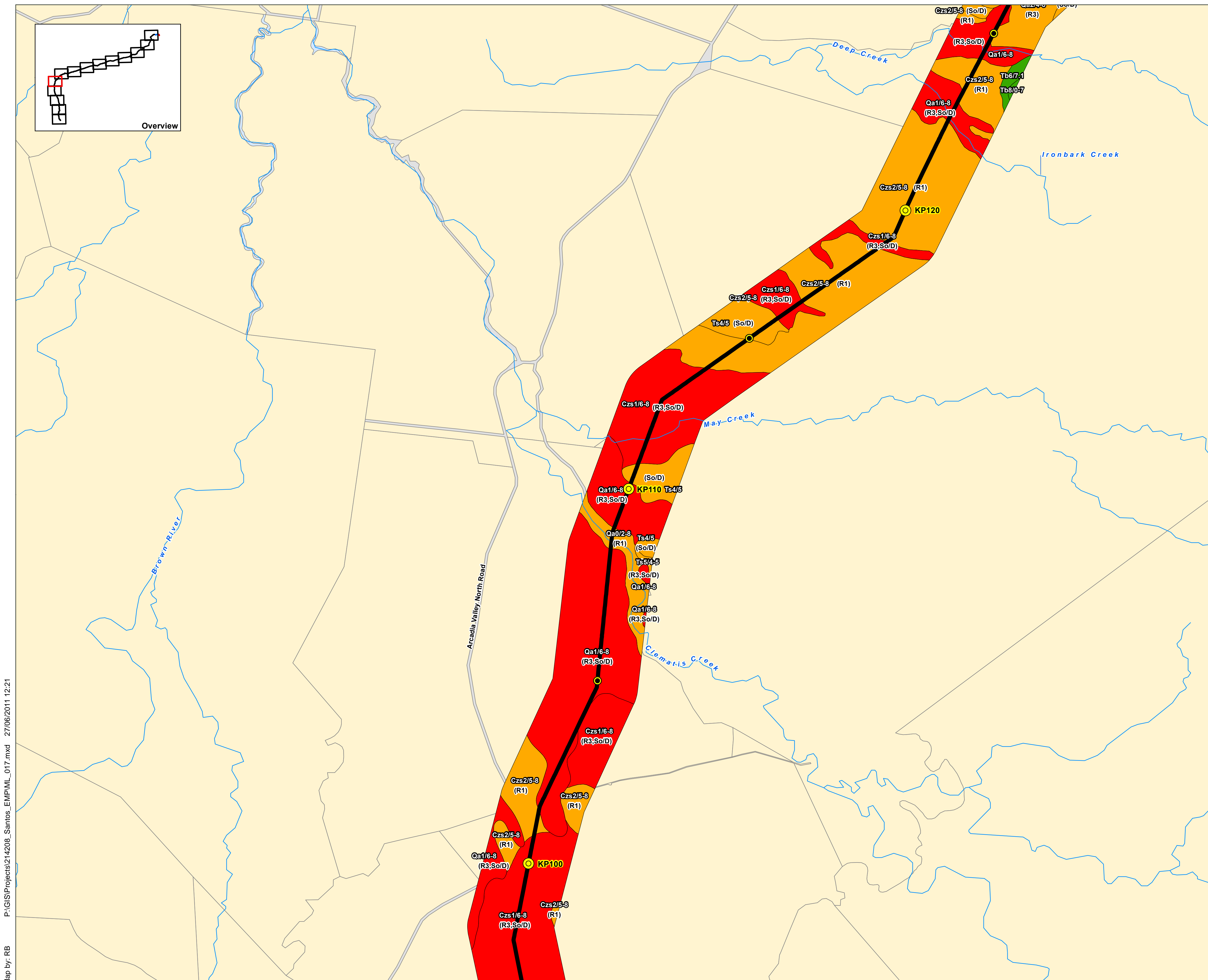
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**Soil Constraints:
 Problem Soils
 Figure 7.6 (Page 5 of 14)**

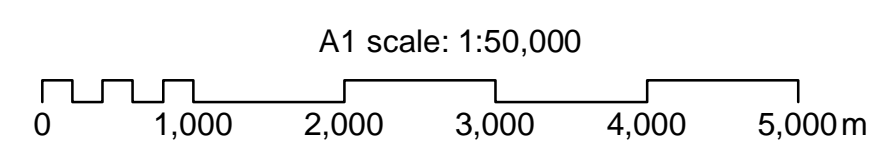
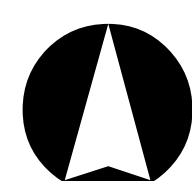
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Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 10km
- 5km

Cadastre

- Rail
- Watercourse

Problem Soils

- High
- Moderate - High
- Moderate
- Low - Moderate
- Low

Description:

R

Soil Reactivity

- L - Nil or low soil
- R1 - Moderately reactive soils
- R2 - Shallow or medium deep, highly reactive (cracking) clay soils
- R3 - Deep, highly reactive (cracking) clay soils

Sa

Soil Salinity

- L - Nil to Low Salinity
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So

Sodicity (ESP)

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- Rating 1 - Sodic, ESP 6-14%
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D

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ASS

Acid Sulfate Soils

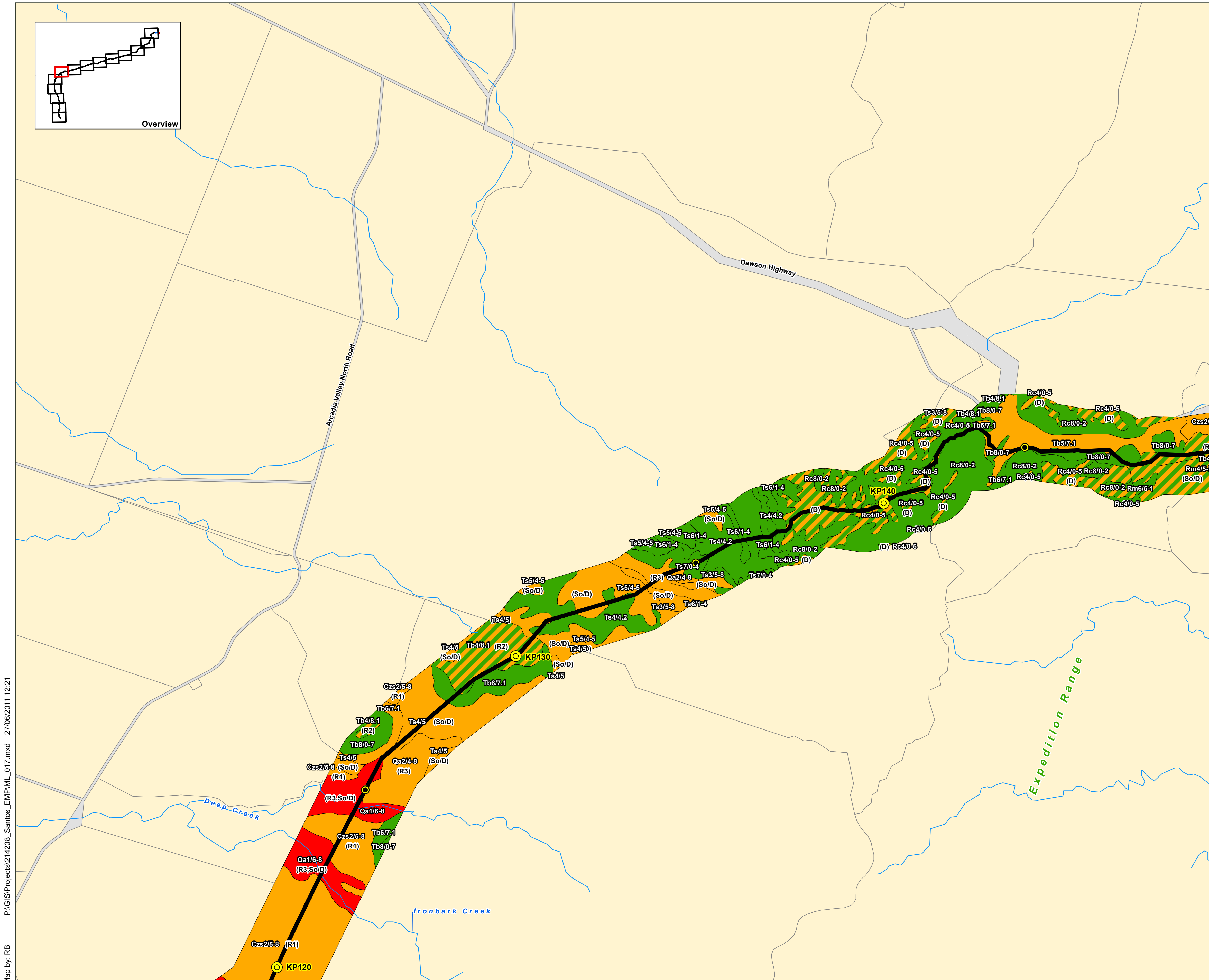
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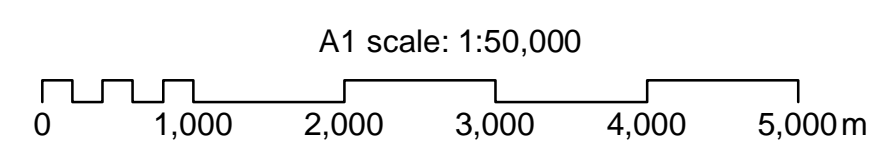
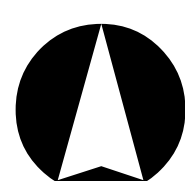
Soil Constraints: Problem Soils Figure 7.6 (Page 6 of 14)

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GLNG No: 3381-40-0410
Coordinate system: GCS_GDA_1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 10km
- 5km

- Cadastre
- Rail
- Watercourse

Problem Soils

- High
- Moderate - High
- Moderate
- Low - Moderate
- Low

Description:

R

Soil Reactivity

- L - Nil or low soil
- R1 - Moderately reactive soils
- R2 - Shallow or medium deep, highly reactive (cracking) clay soils
- R3 - Deep, highly reactive (cracking) clay soils

Sa

Soil Salinity

- L - Nil to Low Salinity
- M - Medium Salinity
- H - High to Very High Salinity

So

Sodicity (ESP)

- N - Very low or non Sodic, ESP <6%
- Rating 1 - Sodic, ESP 6-14%
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Dispersion Class

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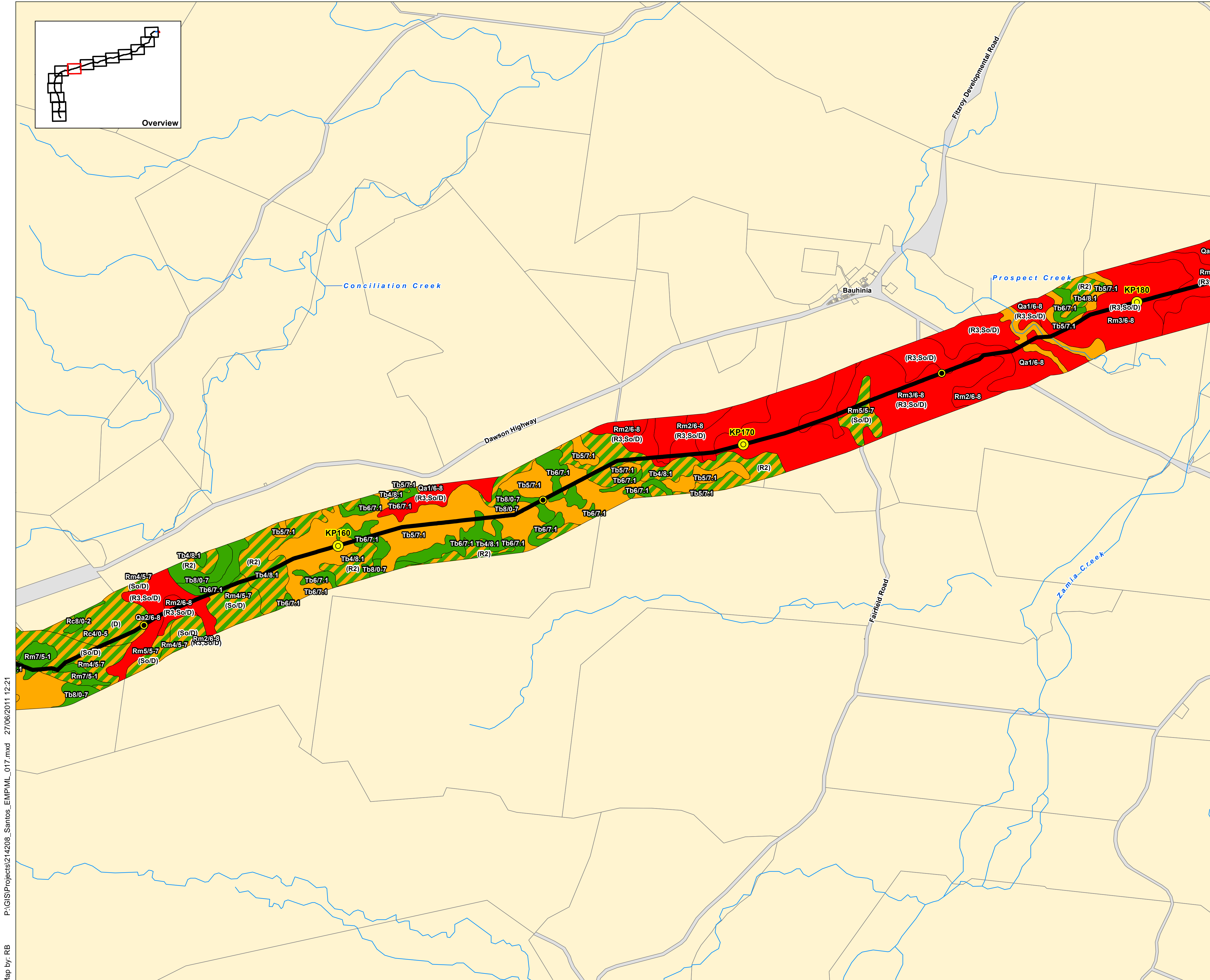
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Acid Sulfate Soils

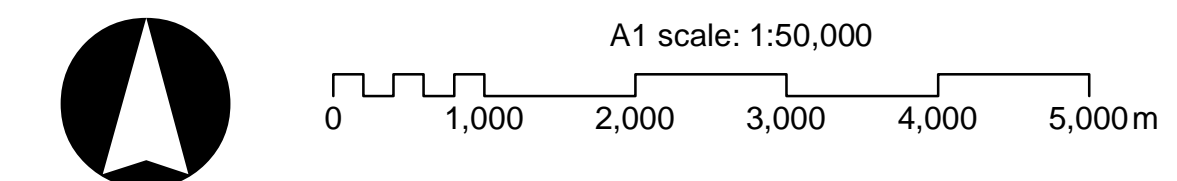
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Soil Constraints: Problem Soils Figure 7.6 (Page 7 of 14)



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Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

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Kilometre Post Distance Marker

- 10km
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- Cadastre
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Problem Soils

- High
- Moderate - High
- Moderate
- Low - Moderate
- Low

Description:

R

Soil Reactivity

- L - Nil or low soil
- R1 - Moderately reactive soils
- R2 - Shallow or medium deep, highly reactive (cracking) clay soils
- R3 - Deep, highly reactive (cracking) clay soils

Sa

Soil Salinity

- L - Nil to Low Salinity
- M - Medium Salinity
- H - High to Very High Salinity

So

Sodicity (ESP)

- N - Very low or non Sodic, ESP <6%
- Rating 1 - Sodic, ESP 6-14%
- Rating 2 - Strongly Sodic, ESP >14-25%
- Rating 3 - Very strongly Sodic, ESP >25%

D

Dispersion Class

- N - Non-dispersive
- Sl - Slightly Dispersive
- M - Moderately Dispersive
- H - Strongly Dispersive

ASS

Acid Sulfate Soils

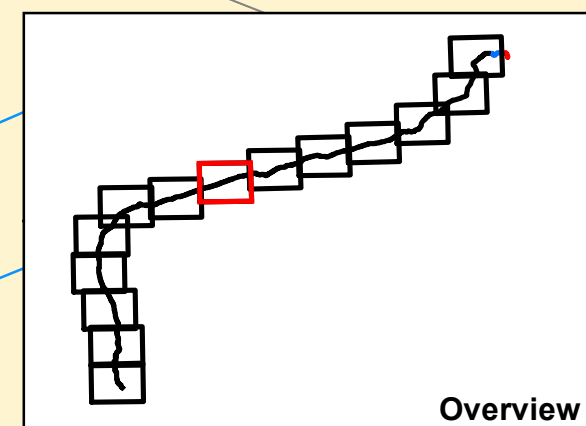
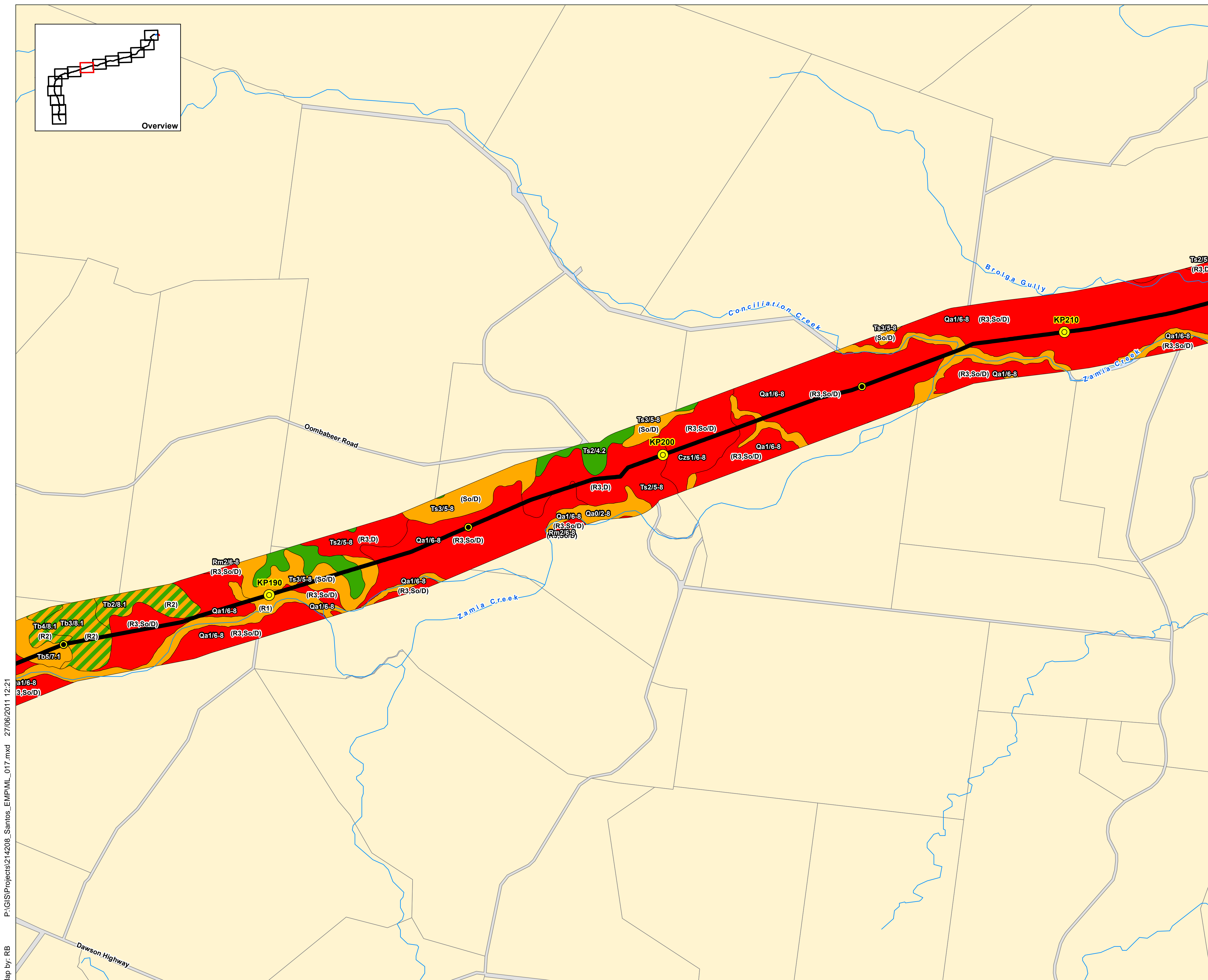
Note: All figures should be reviewed in conjunction with Table 7.1 "Generic Key to the identification of Terrain Units", URS 2009.

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 GLNG Terrain Units: Supplementary EIS, URS, 2009.

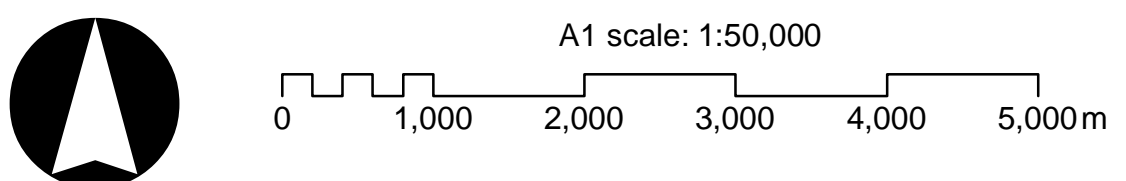
Soil Constraints: Problem Soils Figure 7.6 (Page 8 of 14)

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Map by: RB



GLNG No: 3381-40-0410
 Coordinate system: GCS_GDA_1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 10km
- 5km

Cadastre

- Rail
- Watercourse

Problem Soils

- High
- Moderate - High
- Moderate
- Low - Moderate
- Low

Description:

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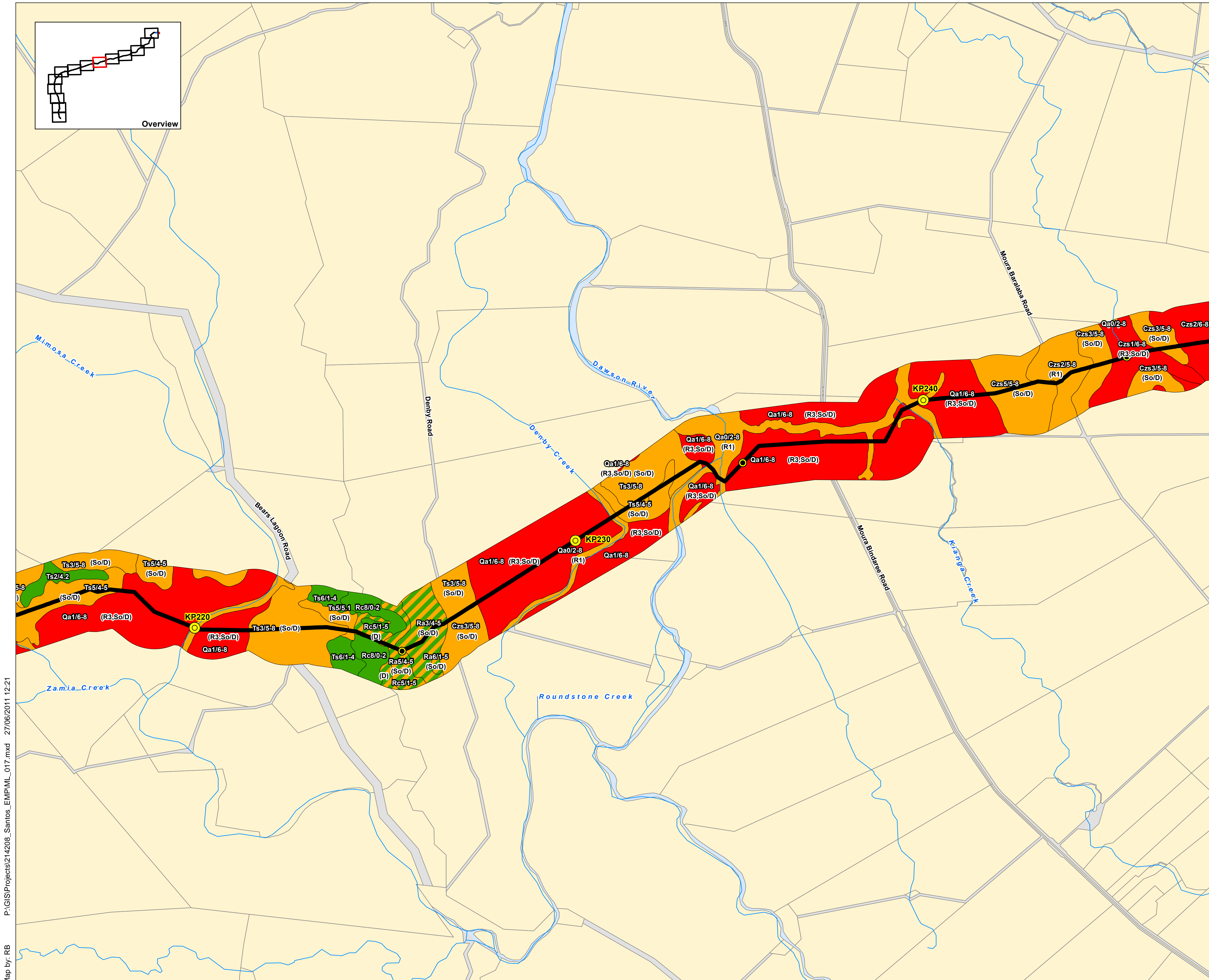
Note: All figures should be reviewed in conjunction with Table 7.1 "Generic Key to the identification of Terrain Units", URS 2009.

Source:
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Cadastre: Department of Management and Resource Management, Jun 2011.
GLNG Terrain Units: Supplementary EIS, URS, 2009.

**Soil Constraints:
Problem Soils**
Figure 7.6 (Page 9 of 14)

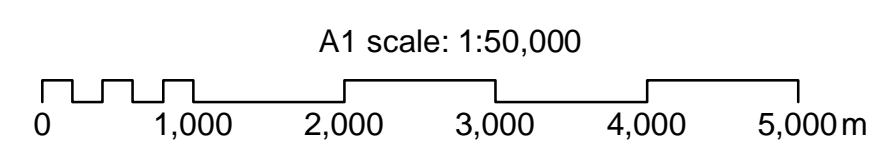
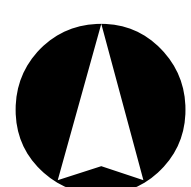
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Map by: RB



GLNG No: 3381-40-0410
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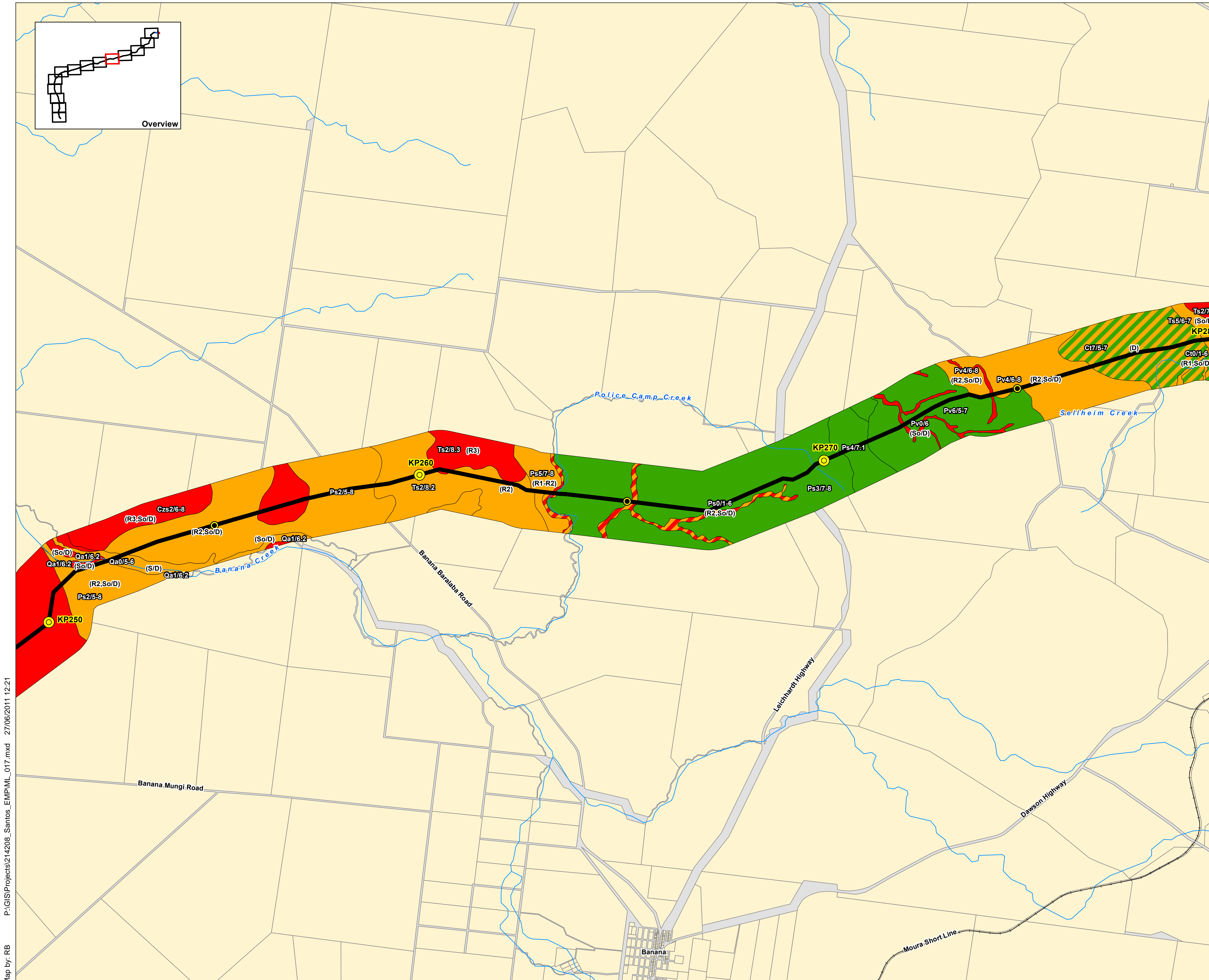
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Soil Constraints: Problem Soils Figure 7.6 (Page 10 of 14)

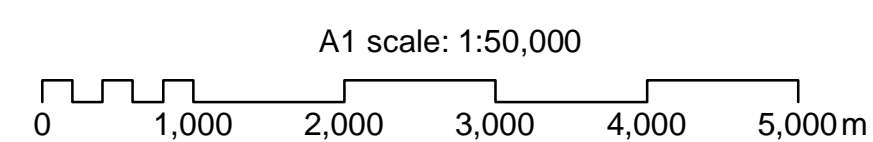
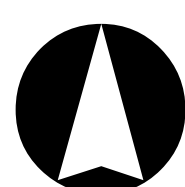
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Map by: RB



GLNG No: 3381-40-0410
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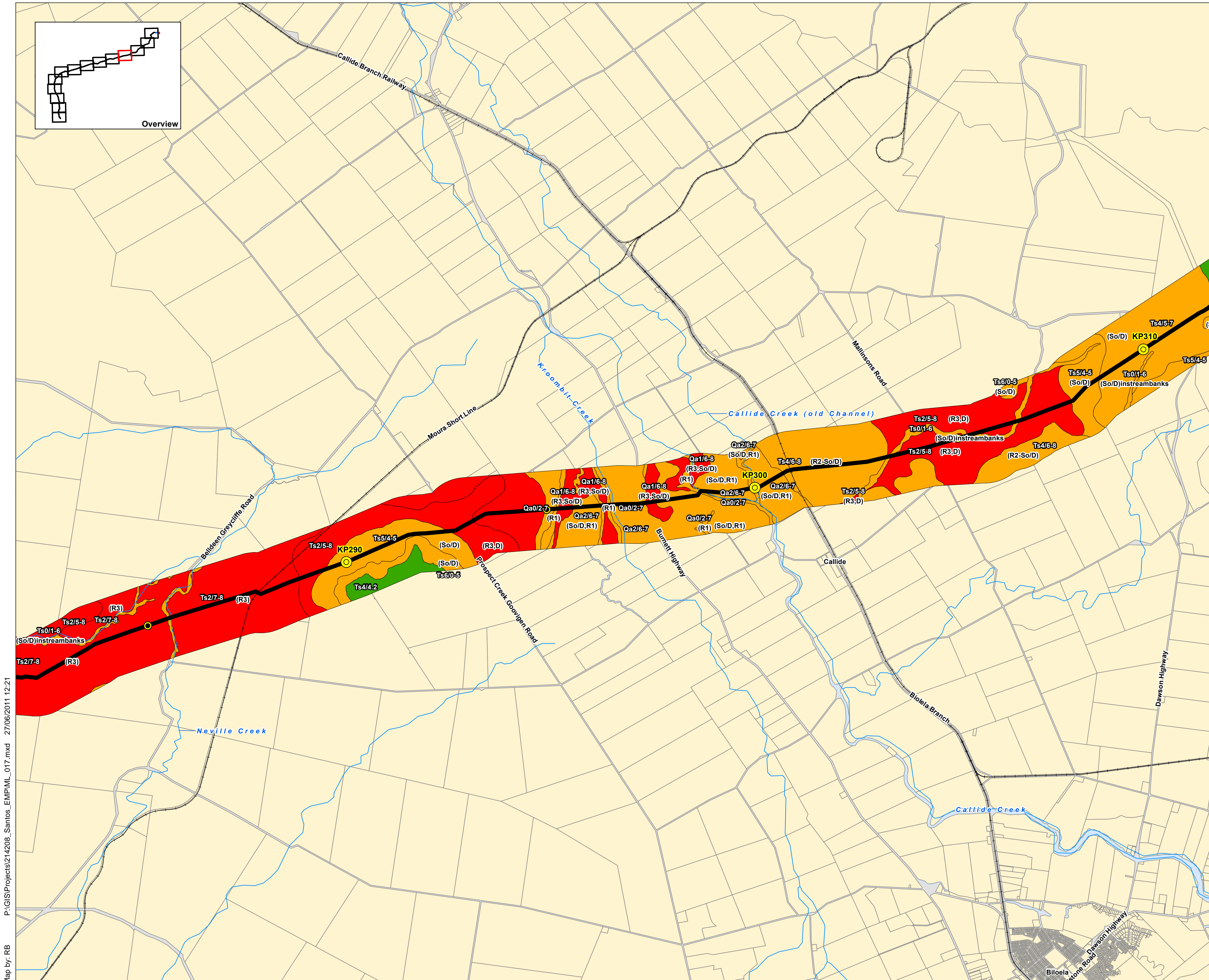
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Soil Constraints: Problem Soils Figure 7.6 (Page 11 of 14)

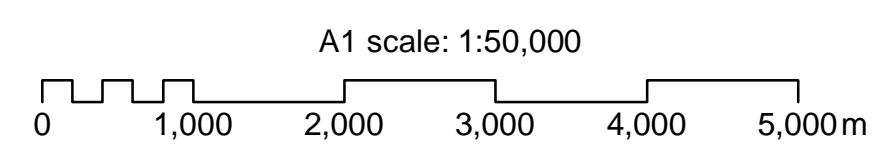
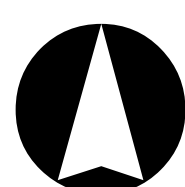
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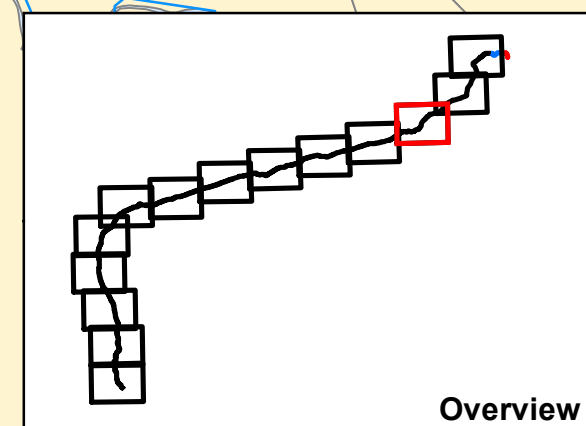
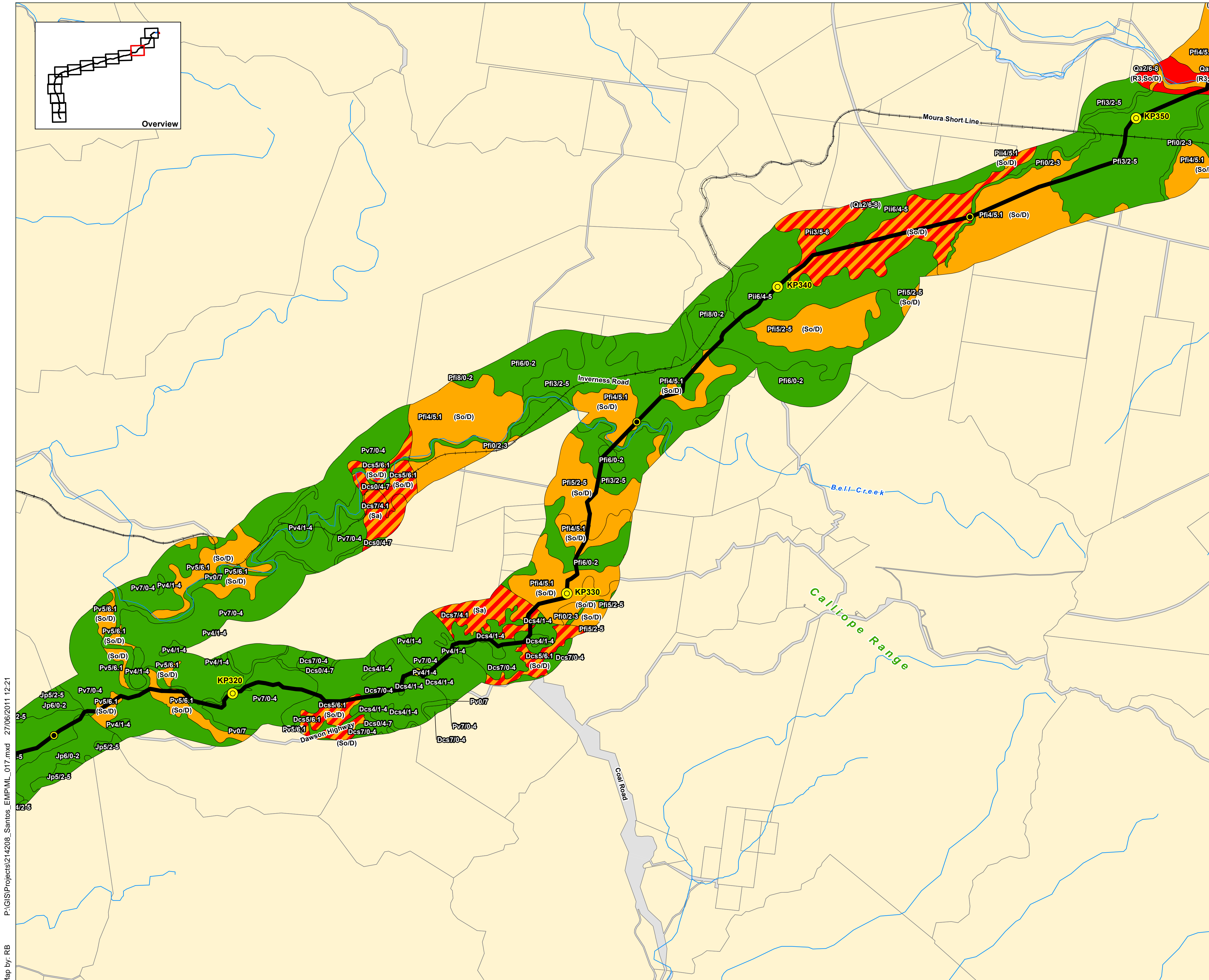
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**Soil Constraints:
Problem Soils**
Figure 7.6 (Page 12 of 14)

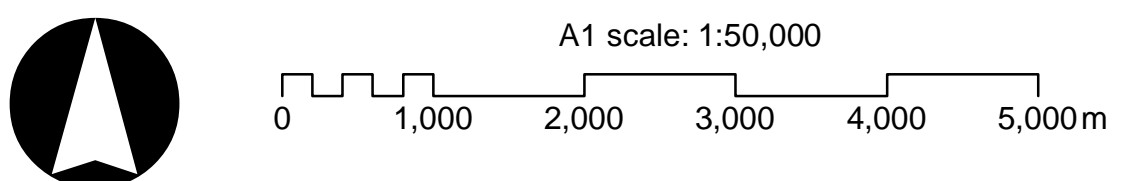
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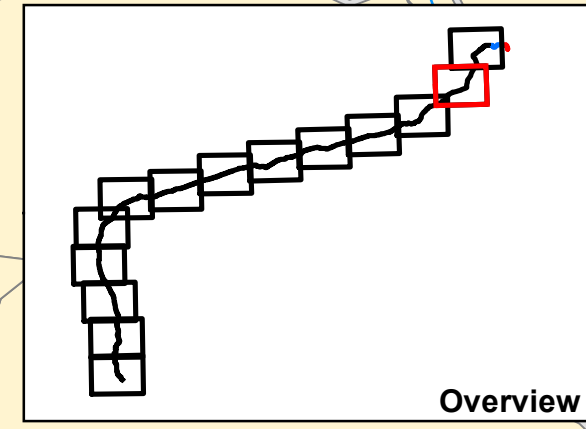
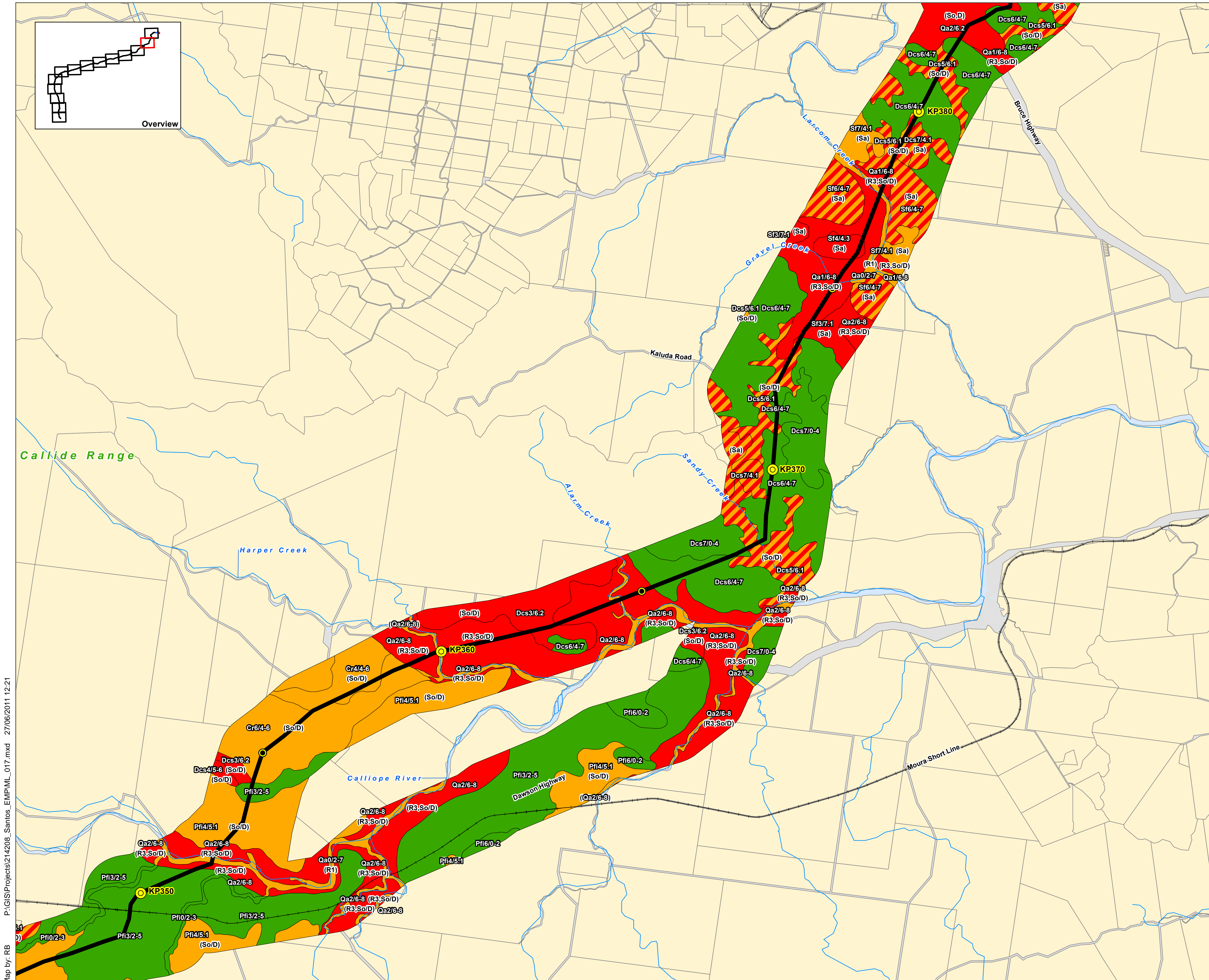
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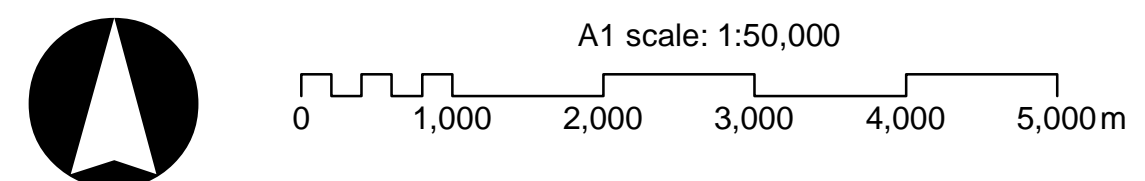
Soil Constraints: Problem Soils Figure 7.6 (Page 13 of 14)

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Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

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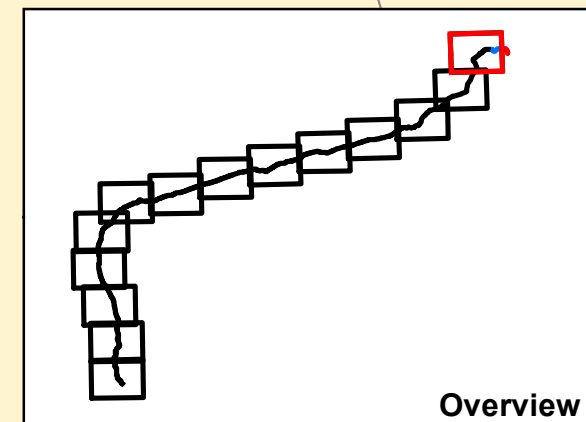
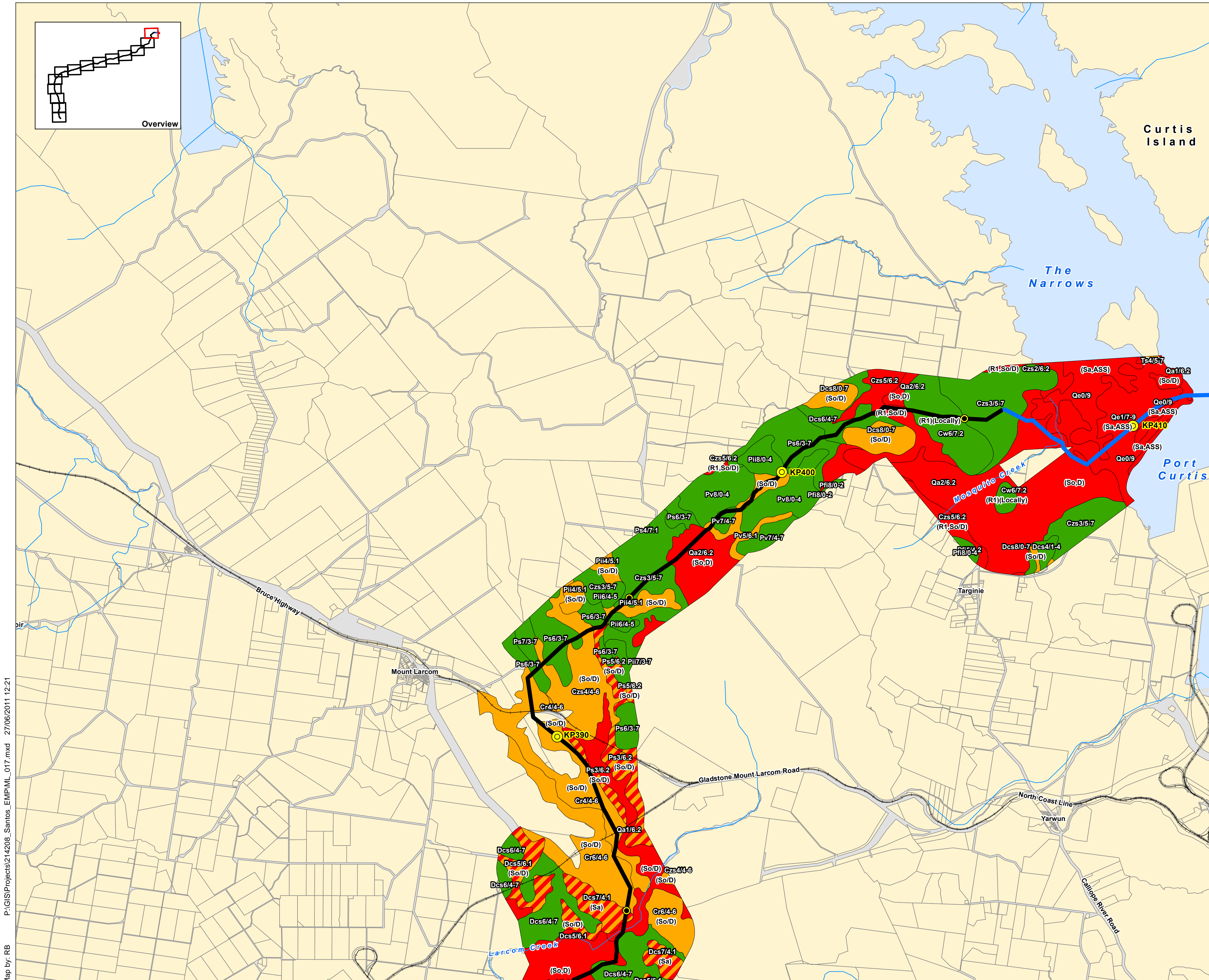
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- GLNG Terrain Units: Supplementary EIS, URS, 2009.

Soil Constraints: Problem Soils Figure 7.6 (Page 14 of 14)

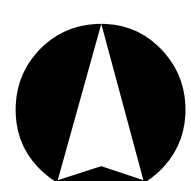
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Overview

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Map by: RB



A1 scale: 1:50,000
0 1,000 2,000 3,000 4,000 5,000m

GLNG No: 3381-40-0410
Coordinate system: GCS_GDA_1994

The distribution of reactive soils associated terrain units within the Mainland GTP RoW is shown as problem soils in Figure 7.6.

Reactive soils (R2 and R3) relate primarily to the occurrence of highly reactive (cracking) clays that occur in terrain units mainly with Soil Group 8 and in places in Soil Group 9. Erodible swelling clay soils (Vertosols) with highly sodic subsoils are present at various locations west of the Calliope Range and are prominent from Biloela and Bauhinia (KP175 to KP300 km).

7.3.10 Acid sulfate soils

The desktop study undertaken during the EIS (URS, 2009) concluded that ASS forming condition do not occur within the Mainland GTP RoW.

7.3.11 Contaminated land

A baseline land contamination assessment of the Mainland GTP was conducted during the EIS (URS, 2009) and the SEIS (URS, 2009). The assessment involved a targeted desktop study aimed at identifying high risk sites or Areas Of Potential Concern (AOPC) on lots which were traversed by the Mainland GTP RoW.

The baseline assessment was conducted in accordance with the Draft Guidelines for the Assessment and Management of Contaminated Land in Queensland (Department of Environment, 1998) and included a Tier 1 and Tier 2 review.

The Tier 1 assessment in the preliminary site investigation identified nine AOPC which are identified in Figure 7.7. Details for each AOPC and findings of the Tier 2 review (including EPA register searches) are provided in Table 7.3 below.

Table 7.3 Areas of potential concern

ID	AOPC	Lot & Plan	EMR	CLR	Land use & Potential Contaminant
1	Quarry	Lot 4 WT217	No	No	Quarry facilities: Fuels, wastes
2	Stockyard	Lot 7 CUE37	No	No	Stockyard: potential cattle dip with pesticide use
3	Open gravel area	Lot 525 CL40243	No	No	Open Gravel patch: unknown land use / contaminants
4	Stockyard	Lot 9 SP200837	No	No	Stockyard: potential cattle dip with pesticide use
5	Industrial plant	Lot 1 SP200852	Yes	No	Industrial plant including several Above Ground Storage Tanks (AST), storage ponds. Current land use comprises integrated waste management, resource recovery, and transport services- potential contaminants include fuels, lubricants, chemicals (unknown)
6	Grass airstrip/hanger	Lot 1 SP108922	No	No	Aeroplane hanger- potential aviation fuels, lubricants
7	Above Ground Storage Tanks	Lot 2 RP605812	No	No	Fuel storage, Stockyard: potential fuels and pesticide contamination
8	Stockyard	Lot 5 RP843128	No	No	Stockyard: potential cattle dip with pesticide use
9	Stockyard	Lot 4 CTN406	No	No	Stockyard: potential cattle dip with pesticide use

Note: EMR – Environmental Management Register
CLR – Contaminated Land Register



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 - Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 50km
- 10km

Contaminated Land Sites

- Cadastral
- Rail
- Watercourse
- Major Road

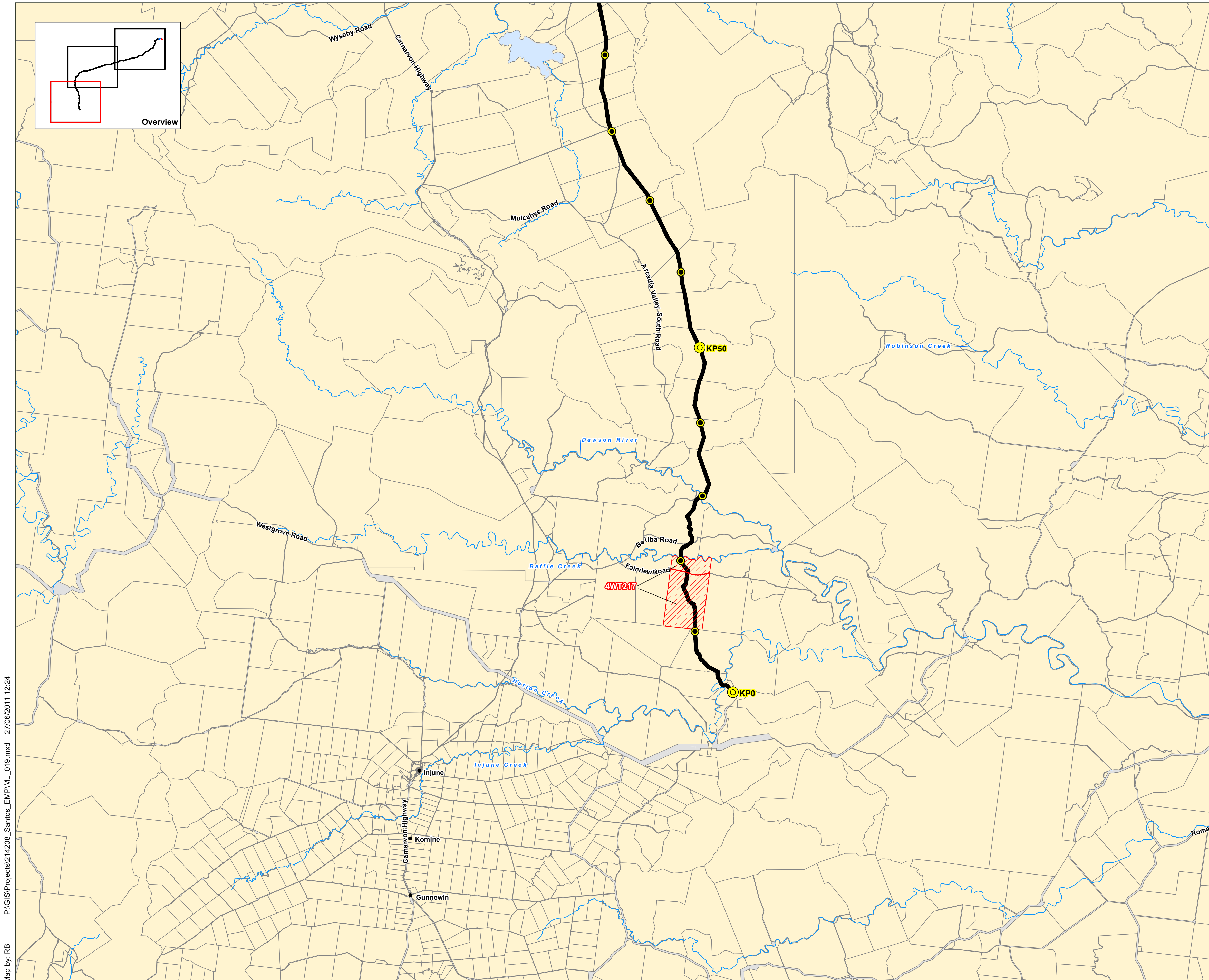
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Contaminated Land Sites Figure 7.7 (Page 1 of 3)

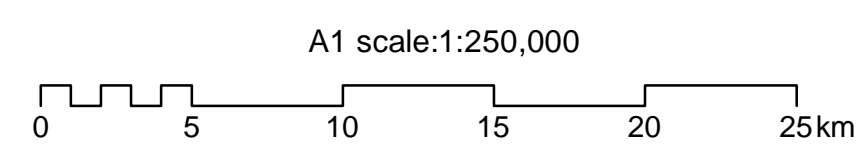
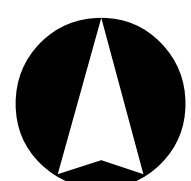
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Map by: RB



GLNG No: 3381-40-0411
Coordinate system: GCS_GDA_1994



Mainland GTP EM Plan

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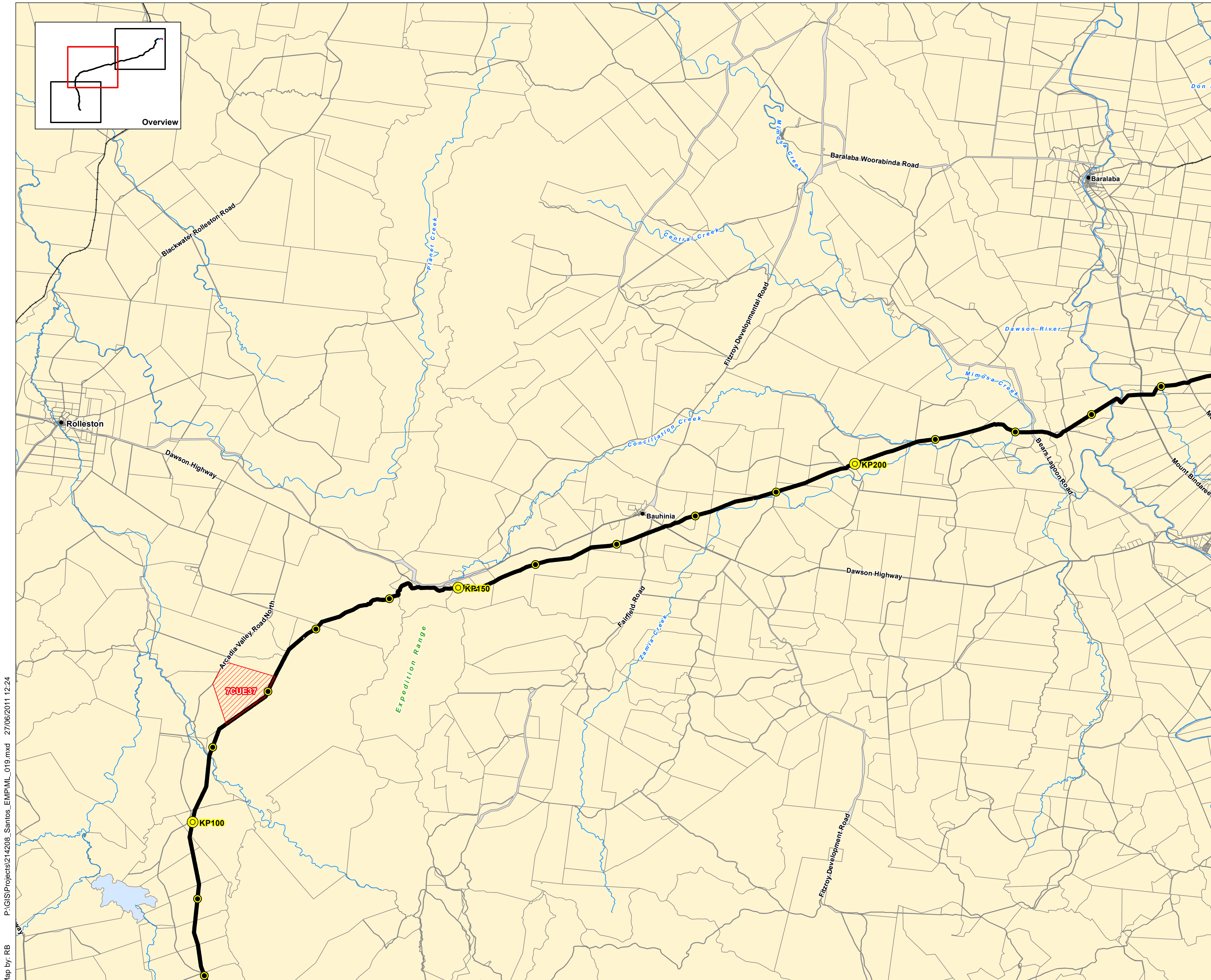
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Contaminated Land Sites Figure 7.7 (Page 2 of 3)

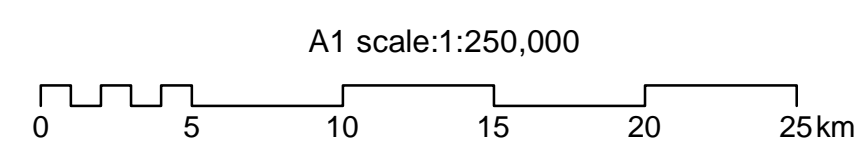
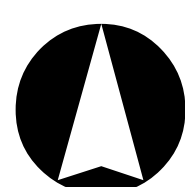
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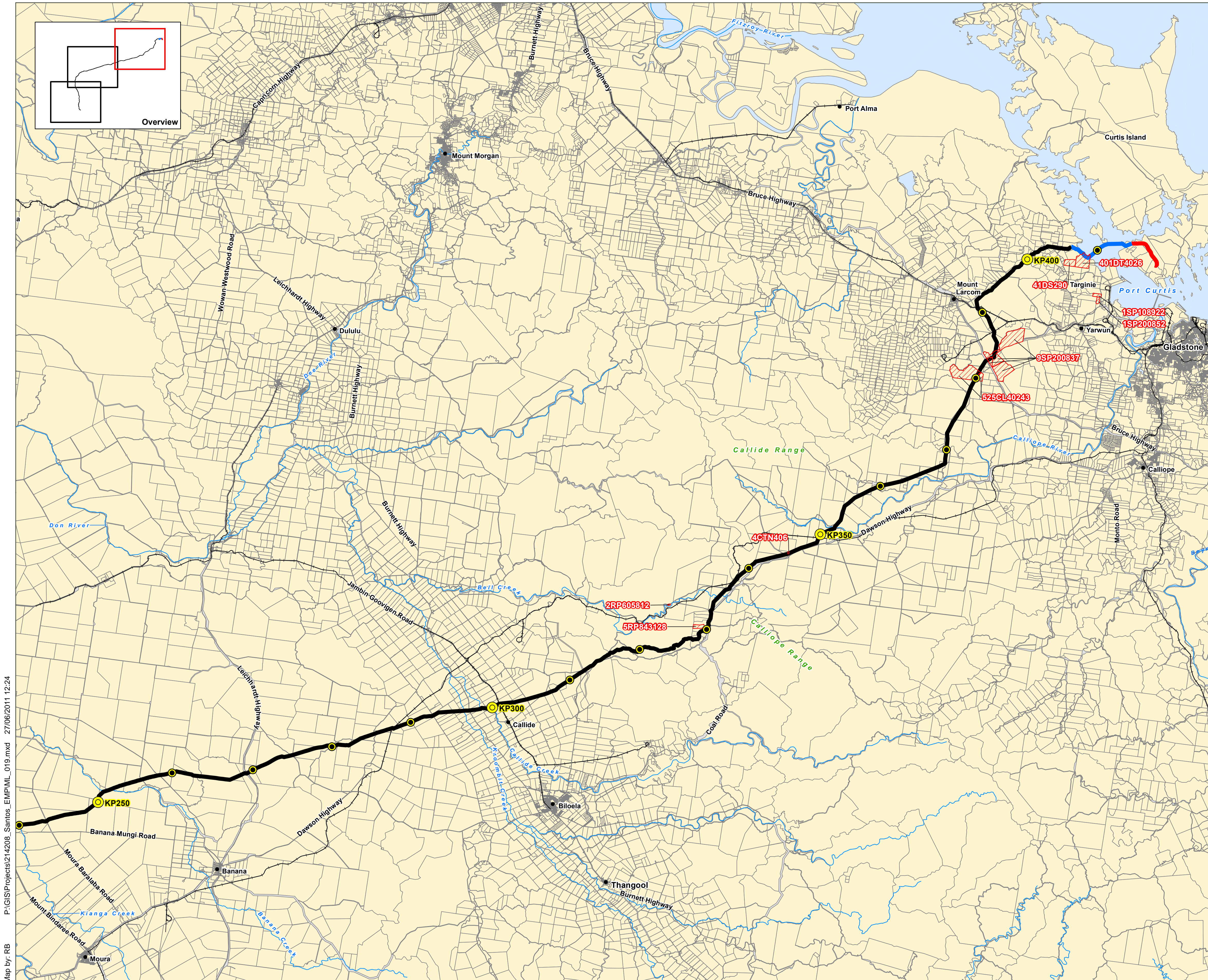
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Contaminated Land Sites Figure 7.7 (Page 3 of 3)

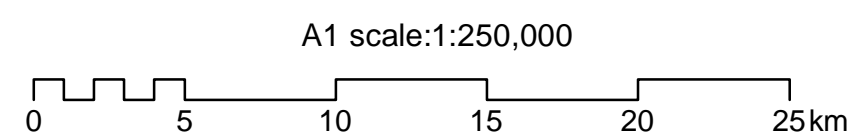
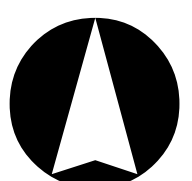
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GLNG No: 3381-40-0411
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Of these AOPC, only the industrial plant (ID5) was listed on the EMR. The industrial plant was listed on the Environmental Management Register (EMR) as Lot 135 RP801113. This lot has since been subdivided to include Lot 1 SP200852. The following notifiable activity was listed for this site:

- Chemical Manufacture or Formulation (blending, mixing or formulating chemicals):
 - Designated dangerous goods under the dangerous goods code
 - Facility with a design capacity of more than one tonne per week

7.3.12 Summary of Environmental Values

Based on the existing geology, topography and soil types within the Mainland GTP RoW, the following have been identified as environmental values.

- Geology and geomorphological processes of the Mainland GTP RoW have given rise to a variety of landform, soil and vegetation types. Therefore, the study area is characterised by localised landform and vegetation variability
- Geological regimes are highly variable, however, sedimentary rocks are dominant
- The Mainland GTP alignment crosses several ranges including the Expedition, Dawson, Cooper, Callide, Calliope, Mt. Alma and Mt. Larcom Ranges. At these locations environmental constraints will be high as rock is likely to be close to surface and gradients may be steep
- The variable topography and undulating relief has resulted in small pockets of variable soil types occurring across the Mainland GTP RoW. The soils of the study area can be separated into nine broad groups (Figure 7.3)
- Some of these soils (generally class 6-8) are classed as GQAL. Small areas of GQAL are located in the CIC and GSDA corridors, with the main areas located near Scrubby Mountain, Mount Larcom, the crossing of the Calliope River and along the Dawson Highway through the Callide Ranges
- The majority of the soils along the alignment are considered to have moderate to high erosion potential
- Saline soils occur in terrain units associated with the Quaternary estuarine deposits and in the Silurian-Devonian extrusive and volcanoclastic geological regimes (Figure 7.1). Moderately to highly saline soils most likely occur in the Quaternary alluvial deposits, mainly in terrain unit Qa1/6-8 and in the older alluvial deposits in terrain units Czs1/6-8 and Czs2/6-8. It is highly likely that subsoils with high salinity potential are present between KP 175 to KP 300
- Sodic soils are indicated along the majority of the Mainland GTP RoW
- Reactive soils occur in terrain units mainly with Soil Group 8 and in places in Soil Group 9. Erodible swelling clay soils (Vertosols) with highly sodic subsoils are present at various locations west of the Calliope Range
- The desktop study undertaken during the EIS indicates that ASS do not exist within the Mainland GTP RoW

A preliminary site contamination investigation undertaken as part of the EIS identified nine Areas Of Potential Concern in proximity to the Mainland GTP RoW (Figure 7.7)

7.4 Potential adverse or beneficial impacts on existing land management values (construction and operation)

The construction and operation of the Mainland GTP RoW related activities and aspects that potentially could contribute to adverse impacts on land management values are discussed in the following sections.

7.4.1 Potential erosion and sedimentation impacts

Construction of the Mainland GTP RoW will involve clearing and earthworks in the general vicinity of the GTP trench, in areas where temporary and permanent access roads are proposed and in associated infrastructure areas.

Potential environmental impacts that may result from construction activities primarily relate to the erosion potential of the land in areas that are subject to clearing or are disturbed including:

- Loss of topsoils and sub-soils due to erosion
- Siltation and sediment movement affecting land and water
- Reduced potential for rehabilitation success due to loss of topsoil
- Higher sediment loads due to accelerated erosion impacts
- Potential for extensive sheet and gully erosion should a high rainfall event occur during construction

As previously discussed, the majority of the soils along the alignment are considered to have moderate to high erosion potential and it is generally the subsoils that have higher erosion potential than the topsoil horizons. Implementation of specific soil conservation measures throughout Mainland GTP RoW construction and operation as described in Section 7.6 including the development of a site specific ESCP (refer to Appendix A), will minimise erosion and reduce sediment loss from disturbed areas.

7.4.2 Potential soil inversion impacts

Trenching activities have the potential to result in soil inversion. Soil inversion can result in the effective “loss” of top soil and may arise due to the mixing of topsoil with trench spoil during stockpiling, covering topsoil with sediment washed in from adjacent areas or returning topsoil and trench spoil to the trench in the wrong order.

Soil inversion can adversely affect easement restoration and revegetation as it limits nutrient availability, biomass and productivity. Soil inversion can also affect soil permeability and water holding capacity. The presence of GQAL or strategic cropping land in the project area means that any potential inversion impacts may reduce land capability and agricultural productivity.

Soil inversion can occur in any soil type along the alignment. Its impacts will be the greatest in sodic soils where sodic material is exposed to the surface. Given that top soil and sub soil will be stockpiled separately and replaced in their original soil horizons, impacts associated with soil inversion are anticipated to be minimal (refer Section 7.6).

7.4.3 Potential soil compaction impacts

Project activities that subject the ground to loading, such as access tracks, lay-down areas and facilities, can cause soil compaction. Once compacted, it can be difficult to return material to its original uncompacted state. This is particularly important in GQAL areas, where compacted soil can cause long-term damage to agricultural land and loss of productivity.

Compaction is more likely to occur in Soil Groups 3-9 (refer Figure 7.3), however, the degree of compaction will be affected by the moisture condition of the soils during the compaction event. Compaction is most likely to occur as a result of vehicles straying from access tracks or from soil being reinstated with inappropriate handling measures.

Mitigation measures for soil compaction associated with these activities are detailed in Section 7.5. It is anticipated that the implementation of these mitigation measures will result in impacts associated with compaction being minimal.

7.4.4 Potential impacts to GQAL and strategic cropping land

The Mainland GTP RoW traverses several areas identified as GQAL and Strategic Cropping Land. The location and extent of this land is described in section 7.3.5. The construction stage is likely to temporarily remove these areas from agricultural production due to installation of the GTP, access roads, lay-down areas and construction camps. The construction phase disturbance footprint will be greater than the footprint required for infrastructure once operational.

The Project activities have the following potential impacts on land:

- Fragmentation of GQAL
- Negative changes to physical and chemical properties of GQAL
- Impeded overland flow of irrigation water on levelled paddocks

The location of GQAL and SCL is presented in Figure 7.4 within a 2 km buffer of the Mainland GTP RoW. Approximately 51.9% of the Mainland GTP RoW will be constructed on land classified as GQAL (Land classes A, B or C1).

Mitigation measures to protect and minimise the impact of construction and operation of the Mainland GTP through areas designated as GQAL and Strategic Cropping Land are detailed in Section 7.6. Mitigation measures to reduce the impact of the project activities are required to be implemented through all stages of the project. Careful soil management and handling, including the successful preservation and reinstatement of topsoil will minimise the impact of the project on GQAL and Strategic Cropping Land. Further management measures for soil preservation are provided in the ESCP (Appendix A)

7.4.5 Potential salinity impacts

Saline areas have been identified as occurring within the Mainland GTP RoW (refer to Section 7.3.7). While the physical construction of the Mainland GTP is unlikely to contribute to salinity in these areas, existing salinity may have the following effects on the Project.

- Salt-affected soil retards plant growth, reducing vegetation cover and, in extreme cases can cause land to be completely unproductive. This may affect rehabilitation attempts of saline soils
- Saline land may be susceptible to wind and water erosion if vegetation cover is reduced
- Soils with high salinity as a result of sodium chloride (eg soil sodicity) can have a tendency to disperse in water, thus increasing the risk of subsurface erosion
- Saline soils can cause corrosion of footings and other susceptible surface infrastructure

Mitigation and management measures to minimise the impacts associated with saline soils are detailed in Section 7.6. It is anticipated that the implementation of these mitigation measures will facilitate successful rehabilitation and therefore result in impacts associated with salinity being minimal.

7.4.6 Differential Settlement of Backfill and Padding

It is likely that backfilled and filled areas will not be returned to original compaction levels. Differential settlement of fill could cause depressions or mounds to form which could potentially lead to drainage concentration and gullyng or waterlogging.

Mitigation and management measures to minimise the impacts associated with differential settlement of backfill and padding are detailed in Section 7.6. It is anticipated that the implementation of these mitigation measures will result in impacts associated with compaction being minimal.

7.4.7 Potential acid sulfate soil impacts

Areas of ASS have not been identified as occurring in the Mainland GTP RoW. Should ASS be encountered prior to construction or at any time during construction, an ASS investigation will be undertaken and an ASS Management Plan will be developed.

7.4.8 Potential soil contamination impacts

Nine existing AOPC have been identified within the Mainland GTP RoW, with one of these sites listed on the EMR. It should be noted that this listing on the EMR does not confirm the presence of contamination.

The major impact associated with AOPC is excavation of potential contaminants during Mainland GTP RoW construction or decommissioning activities, mobilisation of such contaminants off-site and exposure of contaminants to workers and the resultant associated risks.

Mitigation and management measures to minimise the impacts associated with soil contamination impacts are detailed in Section 7.6. Should contaminated soils be encountered during construction then a remediation plan to manage the risk associated with the contaminated soils will be developed and submitted to DERM.

7.4.9 Summary of potential impacts

Construction

The construction of the Mainland GTP has the potential to generate a range of impacts which will require management during construction. Potential impacts on geology and topography will be limited to acceptable and manageable levels, however soil related impacts present a greater risk.

Without the appropriate mitigation measures, the construction of the Mainland GTP may result in a range of soil related impacts including accelerated erosion, generation of sediment, soil inversion and soil compaction. Short term impacts to GQAL and Strategic Cropping Land may occur during construction. Of these impacts, soil erosion and sediment presents a slightly higher risk as the soils within the Mainland GTP RoW are identified as having a moderate to high erosion potential. Providing the recommended management and mitigation measure from Section 7.6 and the ESCP (refer Appendix A) are successfully implemented, the residual impact can be limited to acceptable and manageable levels.

All other impacts identified to soils including soil inversion, soil compaction, salinity, differential settlement and impacts to GQAL and Strategic Cropping Land can also be limited to tolerable levels providing the management and mitigation measures as detailed in Section 7.6 and the LRMP (refer to Appendix G) are successfully implemented.

For proposed construction camp sites, development within these areas will be subject to the mitigation measures outlined in Table 7.4, in addition to site specific erosion and sediment control plans being developed for each site. The size of construction camps will decrease as construction activities in their particular sections are completed. Pre-fabricated modular buildings (camp units) will be transported to the next location and installed to accommodate construction personnel shifting from one section to the next. Once all camp facilities have been relocated to the next location, the site will be rehabilitated as per the measures outlined in the LRMP (refer to Appendix G) and Chapter 15 of this EM Plan.

Operation

Regular inspections will be carried out along the Mainland GTP RoW by vehicle and foot patrols to check on the condition and identify any activities that may have the potential to impact on the integrity of the pipeline. The soil related impacts as outlined and described above will also apply to a lesser extent resulting from the operation of the Mainland GTP.

Operational and maintenance activities involve low numbers of vehicles movements and infrequent maintenance activities. These activities will be undertaken in accordance with the ESCP and OMP. Consequently, the risk of impact from operational and maintenance activities is considered to be low and manageable.

The OMP will be developed prior to construction and implemented during all stages of the Project, including construction, operation and decommissioning. Typical OMP control measures have been outlined in Section 7.6.

7.5 Cumulative impacts

Cumulative impacts on land and land management practices are described below. This cumulative impact assessment is based on the impact scope, identification and scoring methodology described in Chapter 2 of this EM Plan. The significance of cumulative impacts on land and land management practices is expected to be negligible to moderately negative. In particular, cumulative soil erosion impacts may occur without coordinated soil erosion control.

7.5.1 Soils (loss of soil quality)

The terrestrial soil groups along the RoW are variable and include a broad range of Australian soil types, including:

- Uniform and gradational coarse textured (sandy) soils
- Medium textured (loamy) soils
- Textured contrast (duplex) soils
- Gradational or uniform fine textured (non-cracking and cracking clay) soil profile forms

The soil groups are characterised by increasingly finer (or more clayey) texture.

Some of these soils are classed as good quality agricultural land (GQAL) (i.e. lands suitable for improved pasture). Several areas of GQAL are located in the CIC and GSDA corridors, with the main areas located near Scrubby Mountain, Mount Larcom, the crossing of the Calliope River and along the Dawson Highway through the Callide Ranges.

Potential degradation of soil quality could occur through:

- Vegetation removal
- Soil quality loss during storage
- Soil compaction and water logging

- Differential settlement of fill
- Spills of fuel, oil and other contaminants

Apart from simply additive effects due to the increased area of disturbance, cumulative impacts on soils from soil quality degradation may arise from:

- Increasing the vulnerability of narrow areas between RoWs where pipelines start to diverge to disturbance from construction activities
- Potentially exacerbated runoff effects
- Increasing the period of soil exposure due to extended construction timeframes
- Extending the revegetation process in adjacent RoWs
- Increased risks of spills from site traffic collisions

Cumulative impacts will arise from combined effects of erosion from one or more construction RoWs open at one time. These will include loss of topsoil quality, and subsequent reduced effectiveness of rehabilitation, as well as reduced stormwater runoff quality and subsequent effects on sensitive aquatic ecosystems.

Locations with particular potential for cumulative impacts on soils are:

- Banks of waterway crossings, particularly along larger watercourses such as the Calliope River and its tributaries, or where banks are steep or exposed
- Areas of steep topography, such as areas through the Callide, Calliope and Mount Larcom Ranges where slopes are 25 to 50%
- Areas of high erosive potential, particularly where sodosols are present, such as areas around Larcom and Sandy Creeks
- Any areas where soils is exposed for a long period of time

Rehabilitation success for each of the individual pipelines may be compromised by adjacent works, although it may be possible to achieve rehabilitation working separately, as long as runoff and erosion from adjacent RoWs are controlled.

There will be moderate negative cumulative impacts on soils (loss of soil quality).

7.6 Proposed environmental protection commitments, objectives and control strategies – land management

The following environmental protection commitments, objectives and control strategies are proposed for land management within the Mainland GTP RoW.

It should be noted that to achieve effective soil management, it is important to determine the extent and characteristics of soil types that occur in the Mainland GTP RoW. As such, a program of ground truthing existing soils mapping and establishing soil management procedures will be undertaken prior to construction.

Table 7.4 Environmental protection commitments, objectives and control strategies for soil

Item	Detail
Environmental Protection Objective	To minimise and manage adverse impacts to soils by: <ul style="list-style-type: none"> • Limiting the occurrence and extent of trench subsidence and soil erosion • Preventing soil inversion • Developing a stable, vegetated RoW post-construction

Item	Detail
Specific Objectives	<ul style="list-style-type: none"> • Erosion controlled and limited to that consistent with “natural processes” such that pipeline cover is maintained and land capability is not reduced • All erosion control strategies implemented and functional • All topsoil stockpiled separately and no spoil piles remain on surface after restoration • All access restricted to designated areas
Control Strategies	<p>Pre construction</p> <ul style="list-style-type: none"> • Soil management procedures will be developed and implemented and include: <ul style="list-style-type: none"> – The establishment of baseline soils information including soil depth, pH, electrical conductivity (EC), chloride, cations (calcium, magnesium and sodium), ESP, particle size and soil fertility (including nitrogen, phosphorous, potassium, sulphur and micronutrients) – A soils monitoring programme outlining parameters to be monitored, frequency of monitoring and maximum limits for each parameter – The identification of soil units within areas to be disturbed by petroleum activities at a scale of 1:100000, in accordance with the “Guidelines for Surveying Soil and Land Resources, 2nd Edition” (McKenzie et al. 2008), “Australian Soil and Land Survey Handbook, 3rd Edition” (National Committee on Soil and Terrain 2009) and “The Australian Soil Classification” (Isbell 2002) – Soil descriptions for the assessment of soils for agricultural suitability, topsoil assessment, erodibility and rehabilitation including: <ol style="list-style-type: none"> 1) shallow cracking clay soils 2) deep cracking clay soils 3) deep saline and/or sodic cracking clay soils with melonholes 4) thin surface, sodic duplex soils 5) medium to thick surface (>15 cm), sodic duplex soils, and 6) non-sodic duplex soils – Detailed mitigation measures and procedures to manage the risk of adverse soil disturbance in the carrying out of the petroleum activity – For areas of GQAL, detailed methods to be undertaken to minimise potential impacts • A copy of the soils management procedures will be made available to the administering authority upon request. • Soil ground truthing will be undertaken, including identification of all sensitive soil and landform areas along the pipeline corridor including GQAL will be cross referenced to known information on land units and land systems. Any variation between identified land values and DERM data sets will be identified and explained. An assessment of the potential impacts will be provided along with appropriate mitigation measures and construction methods applicable to the identified soil types or landforms including protection and restoration of GQAL that could qualify as strategic cropping land under the Government's draft discussion paper Protection of Strategic Cropping Land • An ESCP, in accordance with Best Practice Erosion and Sediment Control – for building and construction sites, 2008, which has been certified by a Certified Professional in Sediment and Erosion Control, or a professional with appropriate experience and/or qualifications accepted by the Administering Authority will be developed and implemented for all stages of pipeline activity prior to construction • The Erosion and Sediment Control Plan for construction will provide appropriate measures to include for the following: <ul style="list-style-type: none"> – Diverting uncontaminated stormwater run-off around areas disturbed by petroleum activities or where contaminants or wastes are stored or handled that may contribute to stormwater – Collecting, treating, reusing or releasing contaminated stormwater runoff and incident rainfall in accordance with the conditions of this environmental authority – Roofing or minimising the size of areas where contaminants or wastes are stored or handled

Item	Detail
	<ul style="list-style-type: none"> - Using alternate materials and or processes (such as dry absorbents) to clean up spills that will minimise the generation of contaminated waters - Erosion and sediment control structures are placed to minimise erosion of disturbed areas and prevent the contamination of any waters - An inspection and maintenance program for the erosion and sediment control features, and - Provision for adequate access to maintain all erosion and sediment control measures especially during the wet season months from December to March - Identification of remedial actions that would be required to ensure compliance with the conditions of this environmental authority <ul style="list-style-type: none"> • Erosion protection measures and sediment control measures will be implemented and maintained to minimise erosion and the release of sediment and contamination of stormwater from disturbed areas. <p>Construction</p> <p><i>Access</i></p> <ul style="list-style-type: none"> • Where present, topsoil will be stripped across the RoW and trench for re-use • Topsoil and subsoil will be stockpiled separately within the easement and all necessary measures will be taken to prevent contamination • Topsoil will be placed on the high side of the RoW on hills and slopes where practicable and safe to do so • Where access is required in the long term, tracks will be constructed with a gravel surface and maintained to permit all weather access. Where access is required for temporary (construction) use only, disturbed areas will be rehabilitated • Disturbed areas will be graded to a level consistent with lands adjacent, pre-stripped topsoil replaced and erosion protection measures installed <p><i>Clearing and grading</i></p> <ul style="list-style-type: none"> • Clearing and grading will be conducted in a manner that: <ul style="list-style-type: none"> - Does not place fill in areas where clearing of vegetation significantly isolates, fragments or dissects tracts of vegetation resulting in a reduction in the current level of ecosystem functioning, ecological connectivity and/or results in a increase in threatening processes - minimises disturbance to land in order to prevent land degradation - ensures that for land that is to be significantly disturbed by petroleum activities (except in areas of highly erosive soils), the top layer of the soil profile is removed; and (a) stockpiled in a manner that will preserve its biological and chemical properties, and (b) used for rehabilitation purposes • Cleared vegetation or soil will not be pushed up against trunks of trees • Cleared vegetation and soil will not be stored against fence lines • Soil stockpiles will not be placed within the bed or banks of watercourses • The stockpiles will be breached in suitable locations (coinciding with designated access roads or tracks, fence lines) to allow vehicular, stock and wildlife access. Vehicular movement over stockpiled soil will not be allowed • Soil and surface stability will be maintained at all times (eg temporary erosion control berms, drains and sediment barriers will be installed as necessary and maintained until final construction clean-up is completed) • Install, maintain and monitor erosion and sediment control devices (eg berms, jute matting) so that ground is stable and vegetation cover is maintained and promoted • Ensure that runoff control devices (eg whoa boys) are maintained and work at all times to prevent erosion • Carry out excavation works in conformity with the provisions of the construction EM Plan • Install permanent erosion controls around active erosion adjacent to the RoW and watercourses as needed to keep areas stable • Maintain sediment control devices to ensure they remain effective including emptying regularly

Item	Detail
	<ul style="list-style-type: none"> • Consider erosion potential, sedimentation and land contamination issues when formulating incident specific emergency responses • Sediment control measures will be used to preserve stockpiled soils to prevent siltation of any land surface and water or blockage of any existing drainage channels • Where erosion management structures are impacted they will be reinstated as quickly as practicable or alternative structures erected to retain an adequate level of erosion control • Temporary and permanent erosion control banks will be installed across slopes and in the vicinity of drainage lines along the easement as necessary to avoid and control stormwater (ie temporary drainage diversion control measures will be installed along the easement and in lay down and storage areas as necessary to avoid and control stormwater runoff) • Permanent trench breakers will be placed at regular intervals along sloping trenches, at the bases of slopes, adjacent to water bodies and wetlands and at road crossings. • Location of trench breakers will be marked prior to backfilling • Erosion control measures put in place prior to construction will be recontoured to the original conditions as soon as practicable following construction, in consultation with the landholder • An inspection and maintenance program for the erosion and sediment control features will be developed • Inspection and maintenance of erosion control devices will ensure adequate access to control devices and identification of measures required to remediate any failures <p><i>Trenching</i></p> <ul style="list-style-type: none"> • Known contaminated areas will be identified on field maps, located on site, fenced and avoided • Trenching supervisor will be instructed in process for handling previously unidentified contaminated areas (eg dip, waste pit) or ASS in the event that any such areas are uncovered during trenching. These will include: <ul style="list-style-type: none"> – Cessation of trenching at the location – Relocation and recommencement of trenching 50 m ahead – Advising Construction Manager and completing an assessment of the potential contamination. This may require the collection and analysis of the soil – Initiating appropriate remedial action based on the assessment. This may include deviating around the site • Topsoil stockpiles will not exceed 1.5 m in height • Trench spoil (subsoils) will be stockpiled separately to topsoil and vegetation • Where practicable, additional topsoil and subsoil from places where cut and fill is required will be stockpiled in a temporary work space, wherever possible, practicable or relevant • Soil stockpiles near drainage lines will be bound with silt fencing on the down slope and placed at least 10 m away (where practicable) from banks (eg unless otherwise outlined in other management plans (eg SSMP). Soil stockpiles will be located at least 10 m from the high banks of watercourses) • Areas of potential ASS will be clearly marked on construction drawings. Where potential or actual ASS is disturbed during trenching, trench spoil must be stockpiled within a contained area • Regular gaps and spaces in the topsoil, subsoil and vegetation stockpile will be provided for fauna movement • The distances between gaps in stockpiles will be reduced at approaches to stream crossings • Trench plugs will be utilised at appropriate intervals to minimise erosion and allow access across the RoW • The pipeline trenches will be left open for the minimum time practicable • The trench will not be left open for extended periods on slopes leading to drainage lines or watercourses

Item	Detail
	<ul style="list-style-type: none"> • Temporary sediment and erosion control devices will be reinstated <p><i>Pipe laying and backfilling</i></p> <ul style="list-style-type: none"> • Compaction will be carried out in layers and will use techniques and equipment that will not damage the pipeline or pipeline coating • Pipe laying crews will prepare for identified third party crossings and will have materials and equipment available • Gentle crown to be left over the trench line to allow for future settlement of soils, with appropriate breaks to allow for natural surface water flows across the RoW • Measures including pipeline markers and landholder liaison will be used to alert third parties to the presence of the buried pipelines. Markers will be installed with appropriate regard to land use • Topsoil will not be used as bedding material • Topsoil will only be reinstated after the excavated spoil has been backfilled and compacted • Compaction is to be completed prior to spreading topsoil • Erosion berms will be constructed across the RoW on slopes to divert rainfall runoff away from the RoW and to discharge onto stabilised areas • Measures will be installed to prevent subterranean water movement along the backfilled trench • Where possible original trench material will be reused to backfill, otherwise measures will be installed to provide a barrier against preferential flow paths associated with backfilled trench • Mounding of the trench backfill to allow for sufficient settling and no development of a linear depression for ponding of water • On land with GQAL Class A, B or C1 the pipeline will be buried to at least 0.9 m below finished land surface, or greater if deep ripping is a normal practice <p><i>Rehabilitation</i></p> <ul style="list-style-type: none"> • Rehabilitated areas will be maintained to ensure: <ul style="list-style-type: none"> - Stability - Erosion control measures remain effective and stormwater runoff does not negatively affect waters - Plants show healthy growth and recruitment is occurring • Subsoil will be respread and compacted over the trench, with crown development, and used for the construction of contour banks on steep slopes and above banks at water crossings • Areas of the RoW will be deep ripped prior to topsoil spreading in consultation with the landholder • The RoW will be re-profiled to original or stable contours, re-establishing surface drainage lines and other land features • Topsoil application will only take place after subsoil respreading and compaction and will be evenly spread and left with a slightly rough surface • Driving vehicles on freshly topsoiled RoW will be prohibited • Subsoil displaced by the pipe, and not utilised in backfill, may be stockpiled in locations approved by the landholder for use during operations • Imported topsoil, of an appropriate quality and weed free, may be required for RoW repairs, and will only be used with landholder approval • Flagging used to identify clearing boundaries and sensitive features will be removed • Erosion and sediment control measures will be installed. Existing soil erosion measures will be reinstated to a condition at least equal to the pre-existing state • Fertilisers and soil supplements will be used only as necessary with the agreement of landholders and authorities

Item	Detail
	<ul style="list-style-type: none"> • On completion of construction on land identified as GQAL all temporary access tracks will be removed, land management and erosion control measures will be implemented and disturbed areas will be lightly ripped, topsoil replaced and surfaces returned to preconstruction land use condition <p>Specific soil issues</p> <p><i>Sodic soils</i></p> <ul style="list-style-type: none"> • Removal of topsoil containing sodic soils will be limited to the area along the trench and where subsoil is to be placed • Clearing methods, in sodic soils, will minimise ground disturbance and maintain intact root stock as far as possible • In areas of sodic soil, vegetation will be mulched and spread to provide additional organic matter to the soil for the reinstatement process • In areas of sodic soil, additional soil and erosion control measures will be implemented where evidence of erosion or scouring is found • Areas of sodic soil will be clearly marked on alignment drawing sheets • Where strongly or very strongly sodic and/or dispersive materials are identified they will not be used for rehabilitation purposes. Suspected sodic or dispersive materials exposed as a result of site earthworks will be treated as appropriate <p><i>Acid sulfate soils (ASS)</i></p> <ul style="list-style-type: none"> • ASS/PASS are not expected to be encountered on the Mainland RoW, should the soils be identified on the RoW then the following typical mitigation measures would be applied. • An ASS investigation would be undertaken for the proposed linear disturbance (excavation, filling) on land areas that may potentially contain ASS (including all areas <5 m AHD) according to the Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils (ASS) in Queensland 1998 <ul style="list-style-type: none"> – Detailed management measures would be provided in accordance with the Queensland Acid Sulfate Soil Technical Manual, Soil Management Guidelines 2002 to the administering authority at least 20 business days prior to commencement of excavation or filling activities within areas identified as potential for containing ASS in the investigation outlined above – Due regard to any comments provided by the administering authority would be taken when implementing ASS management measures • The location of AASS or PASS would be clearly indicated on design drawings, alignment sheets and in the field. Cross references would be made to relevant management protocols • Where potential or actual ASS is disturbed during trenching, the spoil would be stockpiled within a contained area. • If ASS material is excavated, immediate steps would be undertaken to segregate and contain the material within approved area sand dealt with according to the established ASSMP. <p><i>Land contamination</i></p> <ul style="list-style-type: none"> • Consultation will continue with landholders prior to construction to determine whether any potential areas of contamination are located within the RoW • A suitably qualified person will be onsite to identify any evidence of contamination in sections of the pipeline identified in the EIS Supplement to be proximal to areas of potential concern (AOPC) • Site-specific and contaminant-specific management measures will be developed for any areas that are not avoidable through realignment of the pipeline • If suspect contamination is found during earthworks, work in that area will stop until a suitably qualified person has inspected the site, the hazard has been assessed and appropriate action has been taken • DERM approval will be obtained if contaminated material must be removed from the work area • All personnel will be made aware of potential contamination issues during induction training

Item	Detail
	<ul style="list-style-type: none"> • Within 3 months post construction, where land has been subject to contamination caused by petroleum activities, the contaminated land status must be investigated in accordance with <i>Environmental Protection Act 1994</i> requirements and the National Environment Protection (Site Assessment) Measure 1999 • Known contaminated areas will be identified on field maps, located on site, fenced and avoided • Trenching supervisor will be instructed in process for handling previously unidentified contaminated areas (eg dip, waste pit) or ASS in the event that any such areas are uncovered during trenching. These will include: <ul style="list-style-type: none"> - Cessation of trenching at the location - Relocation and recommencement of trenching 50 m ahead - Advising Construction Manager and completing an assessment of the potential contamination. This may require the collection and analysis of the soil • Initiating appropriate remedial action based on the assessment. This may include deviating around the site <p><i>GQAL and Strategic Cropping Land</i></p> <ul style="list-style-type: none"> • Soil management procedures will be developed and implemented and include for areas of GQAL, detailed methods to be undertaken to minimise potential impacts • Soil ground truthing will be undertaken, including identification of all sensitive soil and landform areas along the pipeline corridor including GQAL will be cross referenced to known information on land units and land systems. Any variation between identified land values and DERM data sets will be identified and explained. An assessment of the potential impacts will be provided along with appropriate mitigation measures and construction methods applicable to the identified soil types or landforms including protection and restoration of GQAL that could qualify as strategic cropping land under the Government's Strategic Cropping Land Bill 2011 • On land with GQAL Class A, B or C1 the pipeline will be buried to at least 0.9 m below finished land surface, or greater if deep ripping is a normal practice • On completion of construction on land identified as GQAL all temporary access tracks will be removed, land management and erosion control measures will be implemented and disturbed areas will be lightly ripped, topsoil replaced and surfaces returned to preconstruction land use condition <p>Operational phase</p> <ul style="list-style-type: none"> • Typical mitigation and controls for the operational phase of the Project will be detailed in the Operational Management Plan, which will be developed prior to construction
<p>Performance Indicators</p>	<ul style="list-style-type: none"> • Erosion is controlled to a degree that is consistent with natural processes • Land capability is not being reduced • Erosion control strategies are functional • Topsoil is stored separately and no spoil piles remain on surface after restoration

8. Land tenure and use

8.1 Chapter summary

This section provides a summary of existing land tenure and use along the Mainland GTP RoW and identifies potential impacts to land tenure and use as a result of proposed construction and operation activities.

8.1.1 Summary of existing land tenure and use values:

- Land tenure along the Mainland GTP RoW is predominantly freehold
- The Mainland GTP RoW passes through 4 Local Government Areas, the Gladstone State Development Area (GSDA) and the Callide Infrastructure Corridor State Development Area (CICSDA)
- The Mainland GTP RoW will cross 16 easements and 32 non easements¹
- The resource tenures relevant to the Mainland GTP RoW include mining leases, mineral development leases, exploration permits for coal and minerals, and petroleum leases and permits
- The predominant existing land use is agriculture
- Gladstone is the largest population centre near to the Mainland GTP RoW, with a number of secondary centres in the outlying rural areas
- The Mainland GTP has multiple infrastructure crossings. They include rail, road and powerlines
- All infrastructure that will be affected due to crossings is listed in Section 8.2.6

8.1.2 Summary of potential impacts to land tenure and use

The Mainland GTP RoW is to be strategically placed to avoid interference and adverse impacts on existing land uses where practical. In addition, the route of all GTP's through the GSDA (23 km) and CICSDA (45 km) consolidates the impacts to these areas as specified in their respective Development Schemes. The main potential impact of the Mainland GTP RoW on agricultural land uses will occur during construction when agricultural and grazing activities will be temporarily restricted, particularly the RoW. Land use can generally recommence following construction, with landholders retaining full access and use of the surface area above the GTP.

Most visual impacts will be temporary since the Mainland GTP will be buried underground and disturbed areas rehabilitated. During operations, there will be mainline valves located along the Mainland GTP and each will be within a small compound of approximately 20 m x 50 m. These will continue to be visible once the Mainland GTP is constructed.

In regards to rail and road, safety protocols will be implemented during any boring and/or drilling stages, or any ground entry points will be set back an appropriate distance so as to not interfere with rail or road infrastructure.

Based on the above, and through implementation of mitigation measures proposed in Table 8.7, potential impacts from construction and operation of the Mainland GTP RoW on land tenure and use are deemed low and manageable.

¹ Non easements refer to interests crossed by GLNG Operations that are not on easements, but still have to be accounted for as crossings; eg minor powerlines, untenured waterways

8.1.3 Summary of proposed mitigation measures for land use and tenure

Table 8.1 Summary of environmental protection commitments, objectives and control strategies – land tenure and use

Item	Detail
Environmental Protection Objective	<ul style="list-style-type: none"> To minimise any social disruption to the local communities from the construction of the pipeline To minimise potential impacts to third party infrastructure during the construction of the pipeline
Specific Objectives	<ul style="list-style-type: none"> No warranted complaints from landholders and the community, and warranted complaints responded to within 2 working days Minimal interruption to third party infrastructure No unauthorised impacts on third party infrastructure
Control Strategies	Refer to Table 8.7 for land use and tenure control strategies to be implemented during construction and operation of the Mainland GTP.
Performance Indicators	<ul style="list-style-type: none"> Report on the performance in management of complaints to the Gladstone Regional Coordination Committee The number of complaints received from stakeholders and the time taken to investigate, take suitable action and close out

8.2 Existing land tenure and use

The Mainland GTP RoW will originate at the gas fields at Roma and Fairview and connect to the Marine crossing section of the GTP on Port Curtis, spanning a distance of approximately 406 km. Land tenure along the Mainland GTP RoW is predominantly freehold (refer Figure 8.1) and passes through four Local Government Areas (Gladstone Regional Council, Banana Shire Regional Council, Central Highlands Regional Council and Maranoa Regional Council) as well as the Gladstone State Development Area (GSDA) and the Callide Infrastructure Corridor State Development Area (CICSDA) (refer Figure 8.2a and 8.2b).

A section of the Mainland GTP RoW, specifically KP 383 to KP 405, will pass through the Aldoga and Targinie Precincts of the GSDA within the Materials Transportation and Services Corridor as shown in the *Development Scheme for the Gladstone State Development Area (December 2010)*. The Mainland GTP RoW also passes through the CICSDA from KP 337 to KP382 as shown in the *Development Scheme for the Callide Infrastructure Corridor State Development Area (October 2009)*.

Construction of gas transportation infrastructure in the Curtis Island Corridor Sub-Precinct of the Materials Transportation and Services Corridor of the GSDA is considered by Schedule 3 of the GSDA Development Scheme as “highly likely” to meet the scheme’s objectives, and a development application for material change of use has already been made under the GSDA Development Scheme for this area.

Construction of gas transportation infrastructure in the CICSDA is considered by Schedule 1 of the CICSDA Development Scheme as “highly likely” to meet the scheme’s objectives, and a development application for material change of use is being made under the CICSDA Development Scheme for this area.

8.2.1 Easements

The Mainland GTP RoW will cross 16 easements and 32 non easements. The existing easements have varying interests held by DERM, Central Highlands Regional Council, Banana Shire Council, or Gladstone Regional Council. These easements are described in Table 8.2 below.



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 50km
- 10km

Land Tenure

- Freehold
- Forest Reserve
- Housing Land
- Industrial Estates
- Lands Lease
- National Park
- Port and Harbour Boards
- Reserve
- Railway
- State Forest
- State Land
- Timber Reserve
- Water Resource
- Easement
- Road Parcel
- Water Parcel
- Rail

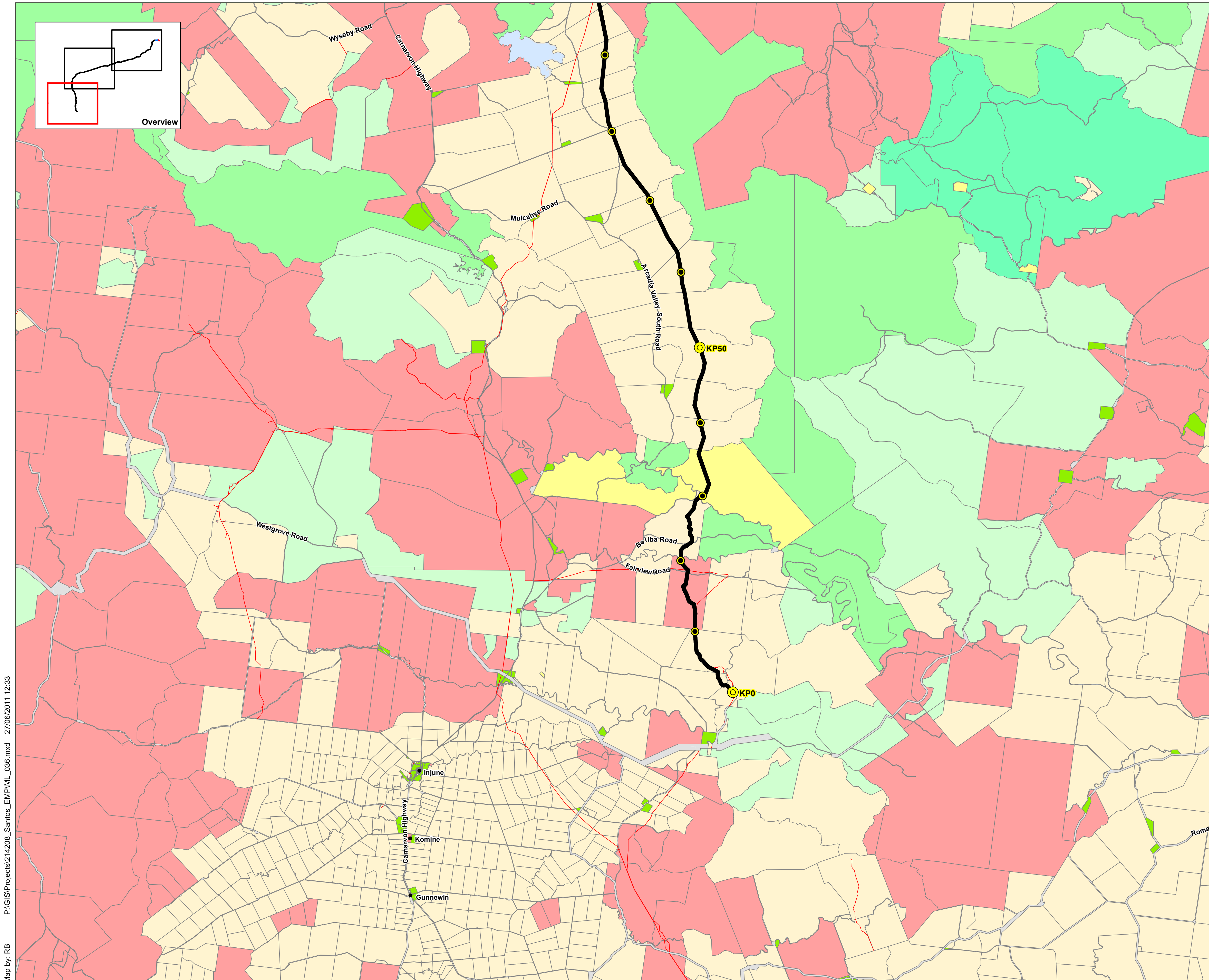
Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Cadastre, Tenure and Easements: Department of
 Environment and Resource Management, Jun 2011.

Land Tenure

Figure 8.1 (Page 1 of 3)

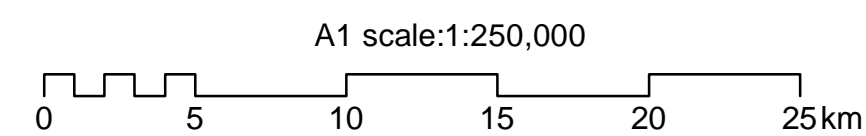
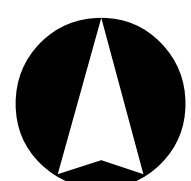
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Map by: RB



GLNG No: 3381-40-0412
 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

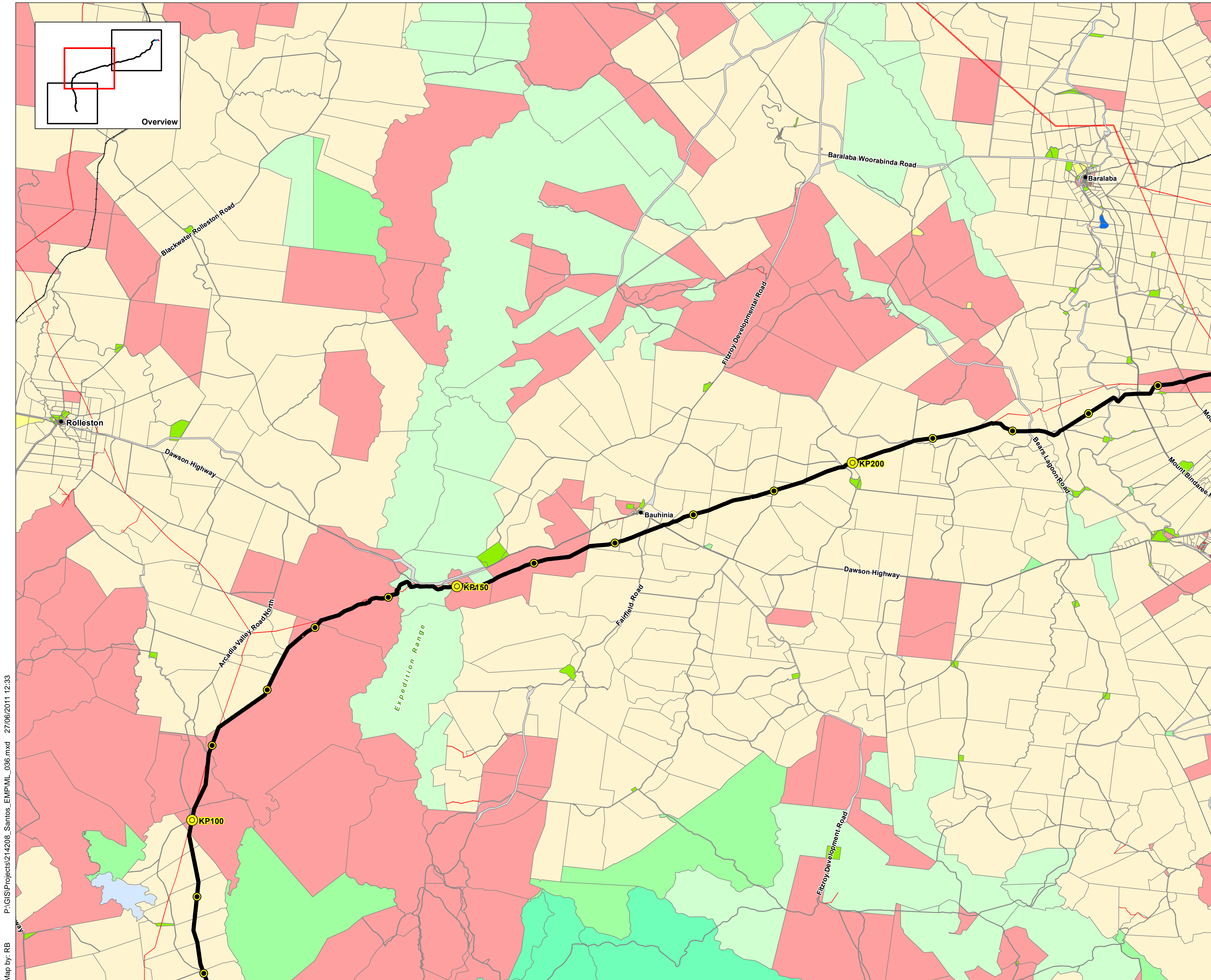
- Gas Transmission Pipeline (GTP)
- Mainland GTP EM Plan
 - Marine Crossing GTP EM Plan
 - Curtis Island GTP EM Plan
- Kilometre Post Distance Marker
- 50km
 - 10km
- Land Tenure
- Freehold
 - Forest Reserve
 - Housing Land
 - Industrial Estates
 - Lands Lease
 - National Park
 - Port and Harbour Boards
 - Reserve
 - Railway
 - State Forest
 - State Land
 - Timber Reserve
 - Water Resource
 - Easement
 - Road Parcel
 - Water Parcel
 - Rail

Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Cadastre, Tenure and Easements: Department of
 Environment and Resource Management, Jun 2011.

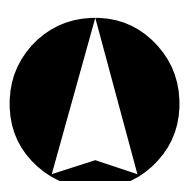
Land Tenure Figure 8.1 (Page 2 of 3)

Date: 27/06/2011

Version: c



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Map by: RB



A1 scale: 1:250,000
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GLNG No: 3381-40-0412
Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 50km
- 10km

Land Tenure

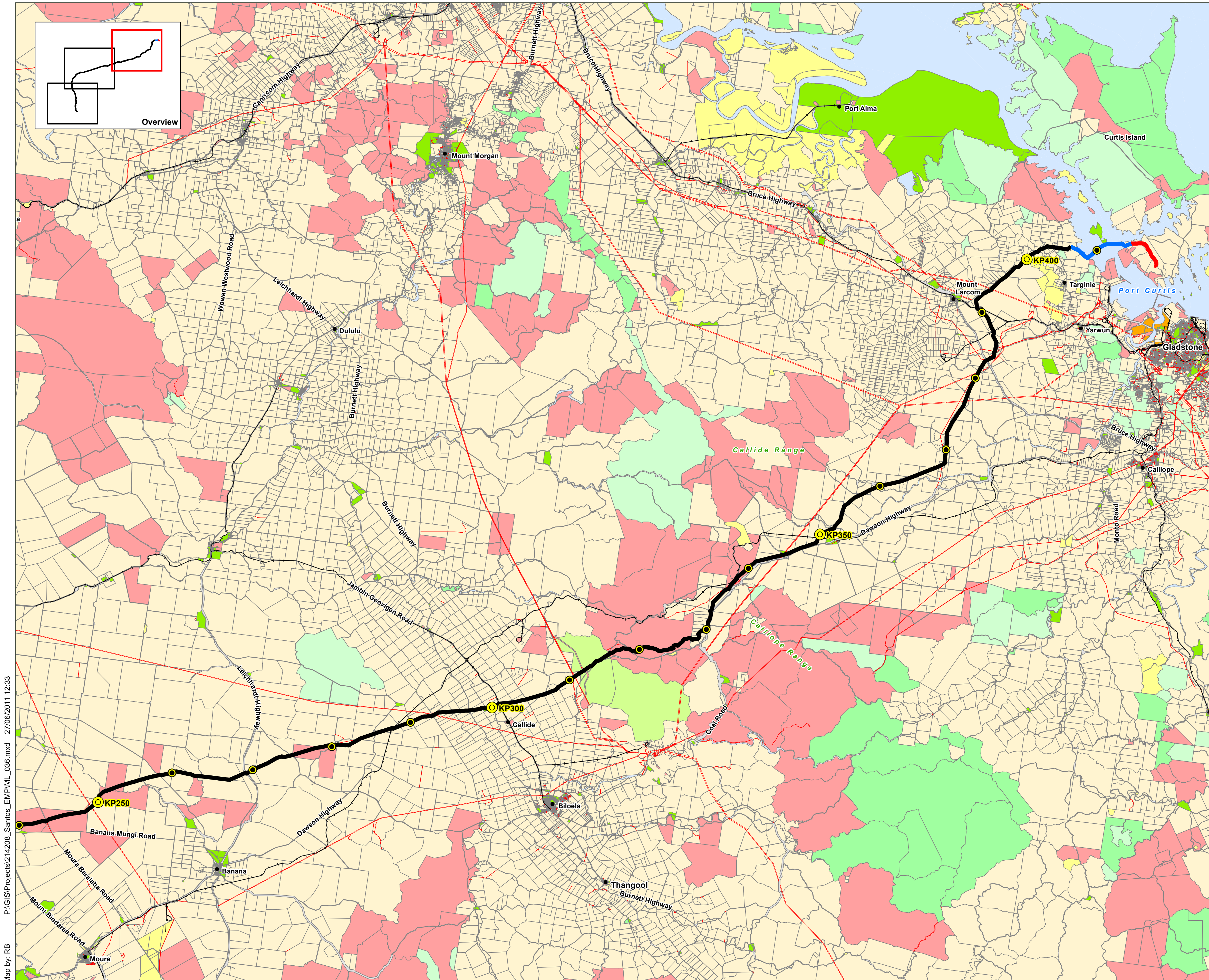
- Freehold
- Forest Reserve
- Housing Land
- Industrial Estates
- Lands Lease
- National Park
- Port and Harbour Boards
- Reserve
- Railway
- State Forest
- State Land
- Timber Reserve
- Water Resource
- Easement
- Road Parcel
- Water Parcel
- Rail

Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Cadastre, Tenure and Easements: Department of
 Environment and Resource Management, Jun 2011.

Land Tenure Figure 8.1 (Page 3 of 3)

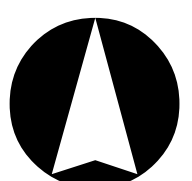
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Map by: RB



A1 scale: 1:250,000
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GLNG No: 3381-40-0412
 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

- Gas Transmission Pipeline (GTP)
 - Mainland GTP EM Plan
 - Marine Crossing GTP EM Plan
 - Curtis Island GTP EM Plan
- Kilometre Post Distance Marker
 - 50km
 - 10km
- Local Government Area Boundary
- Callide Infrastructure Corridor State Development Area
- Gladstone State Development Area
- Cadastral
- Rail
- Watercourse

Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Cadastral: Department of Environment and Resource Management, Jun 2011.
 Local Government Area Boundaries: DERM, Jan 2011.
 Callide Infrastructure Corridor State Development Area: Santos, Mar 2011,
 Gladstone State Development Area: Santos, Feb 2011

State Development Areas and LGA Boundaries
Figure 8.2a (Page 1 of 3)

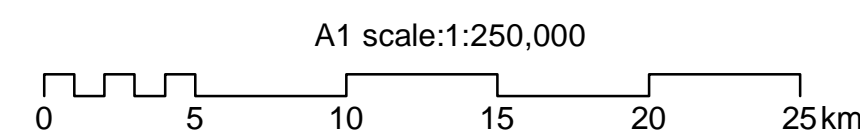
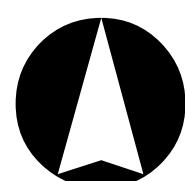
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 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

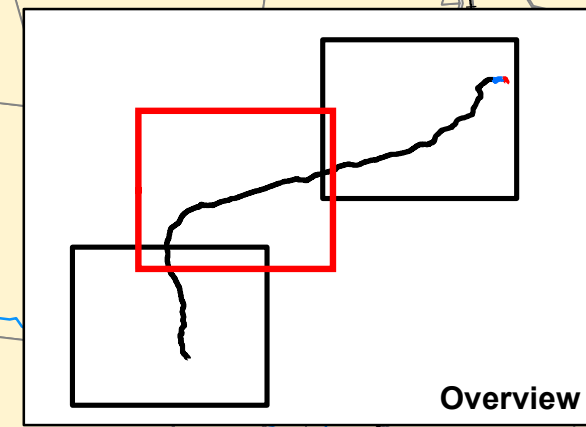
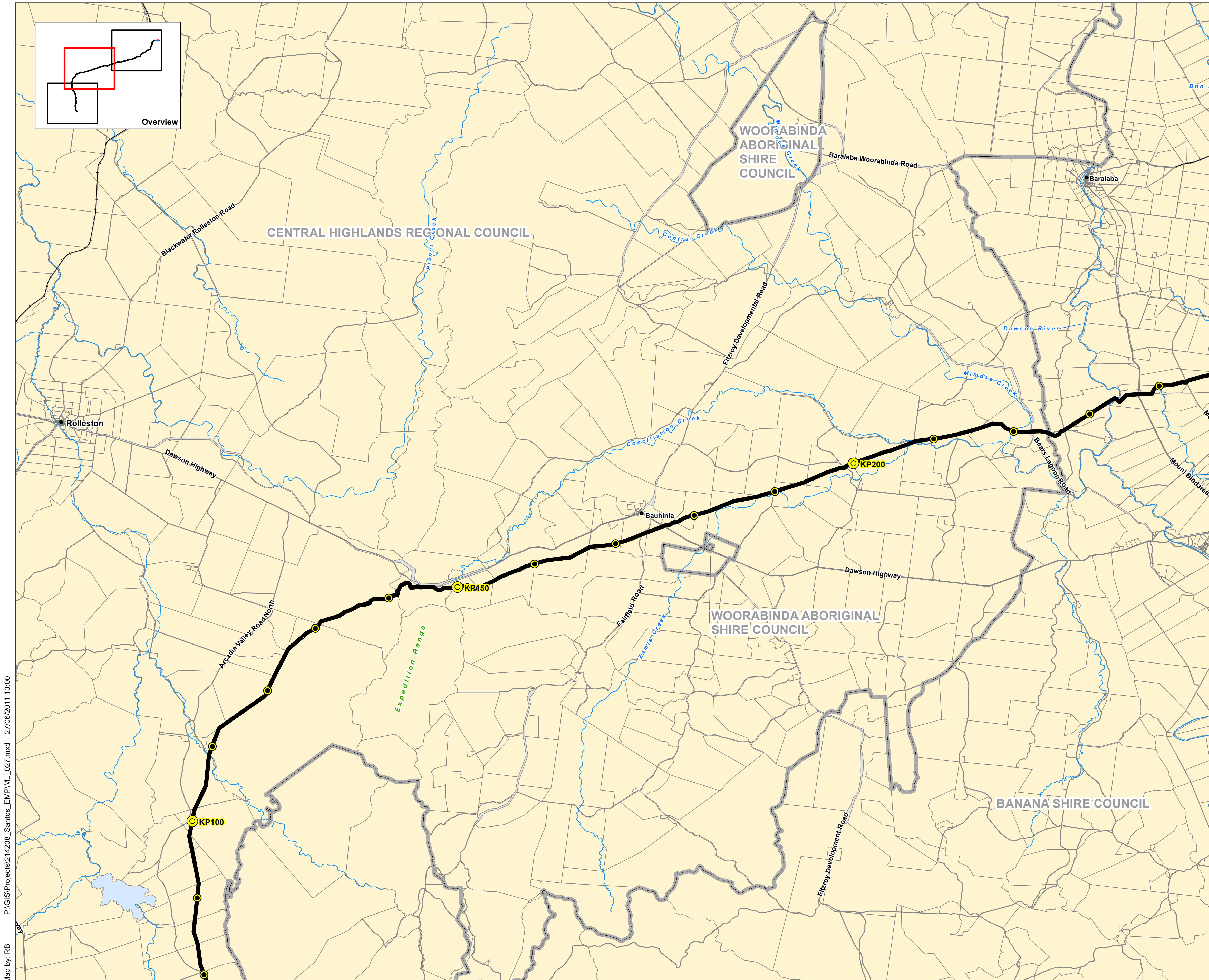
- Gas Transmission Pipeline (GTP)
 - Mainland GTP EM Plan
 - Marine Crossing GTP EM Plan
 - Curtis Island GTP EM Plan
- Kilometre Post Distance Marker
 - 50km
 - 10km
- Local Government Area Boundary
- Callide Infrastructure Corridor State Development Area
- Gladstone State Development Area
- Cadastre
- Rail
- Watercourse

Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Cadastre: Department of Environment and Resource Management, Jun 2011.
 Local Government Area Boundaries: DERM, Jan 2011.
 Callide Infrastructure Corridor State Development Area: Santos, Mar 2011.
 Gladstone State Development Area: Santos, Feb 2011

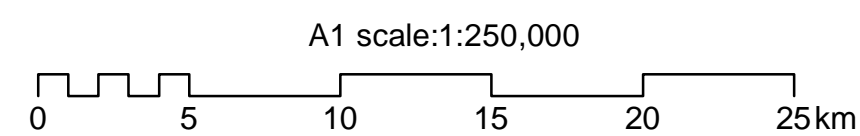
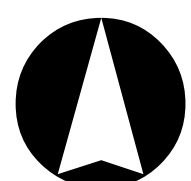
**State Development Areas and
LGA Boundaries**
Figure 8.2a (Page 2 of 3)

Date: 27/06/2011

Version: c



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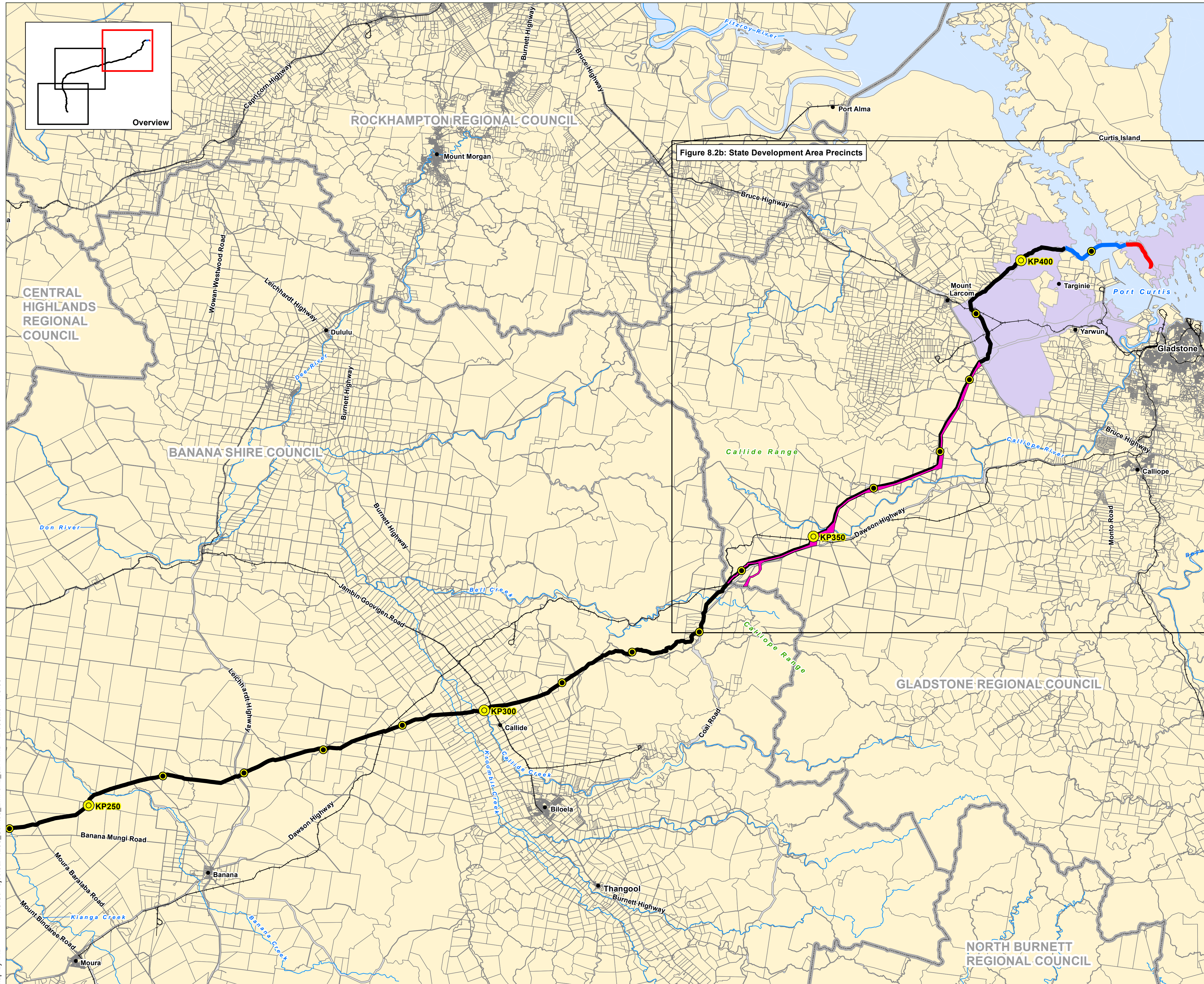


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Mainland GTP EM Plan

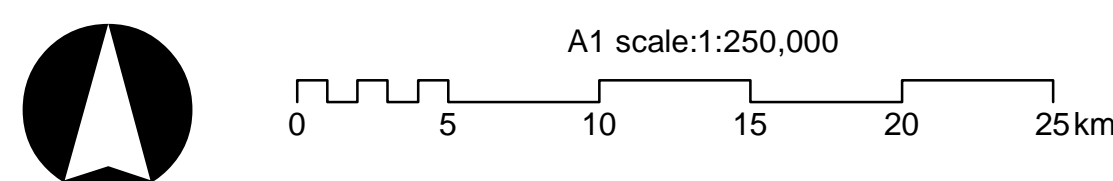
- Gas Transmission Pipeline (GTP)
 - Mainland GTP EM Plan
 - Marine Crossing GTP EM Plan
 - Curtis Island GTP EM Plan
- Kilometre Post Distance Marker
 - 50km
 - 10km
- Local Government Area Boundary
- Callide Infrastructure Corridor State Development Area
- Gladstone State Development Area
- Cadastral
- Rail
- Watercourse



Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Cadastral: Department of Environment and Resource Management, Jun 2011.
 Local Government Area Boundaries: DERM, Jan 2011.
 Callide Infrastructure Corridor State Development Area: Santos, Mar 2011.
 Gladstone State Development Area: Santos, Feb 2011

State Development Areas and LGA Boundaries
Figure 8.2a (Page 3 of 3)

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 Map by: RB



GLNG No: 3381-40-0413
 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 50km
- 10km

Local Government Area Boundary

- Local Government Area Boundary
- Callide Infrastructure Corridor State Development Area

Gladstone State Development Area Precinct

- Aldoga Precinct
- Clinton Precinct
- Corridor Buffer Area Precinct
- Curtis Island Industry Precinct
- Environmental Management Precinct (Curtis Island)
- Environmental Management Precinct (Kangaroo Island)
- Materials Transportation and Services Corridor
- Stuart Oil Shale Reserve Preservation Area
- Targinnie Precinct
- Yarwun Precinct

Cadastral

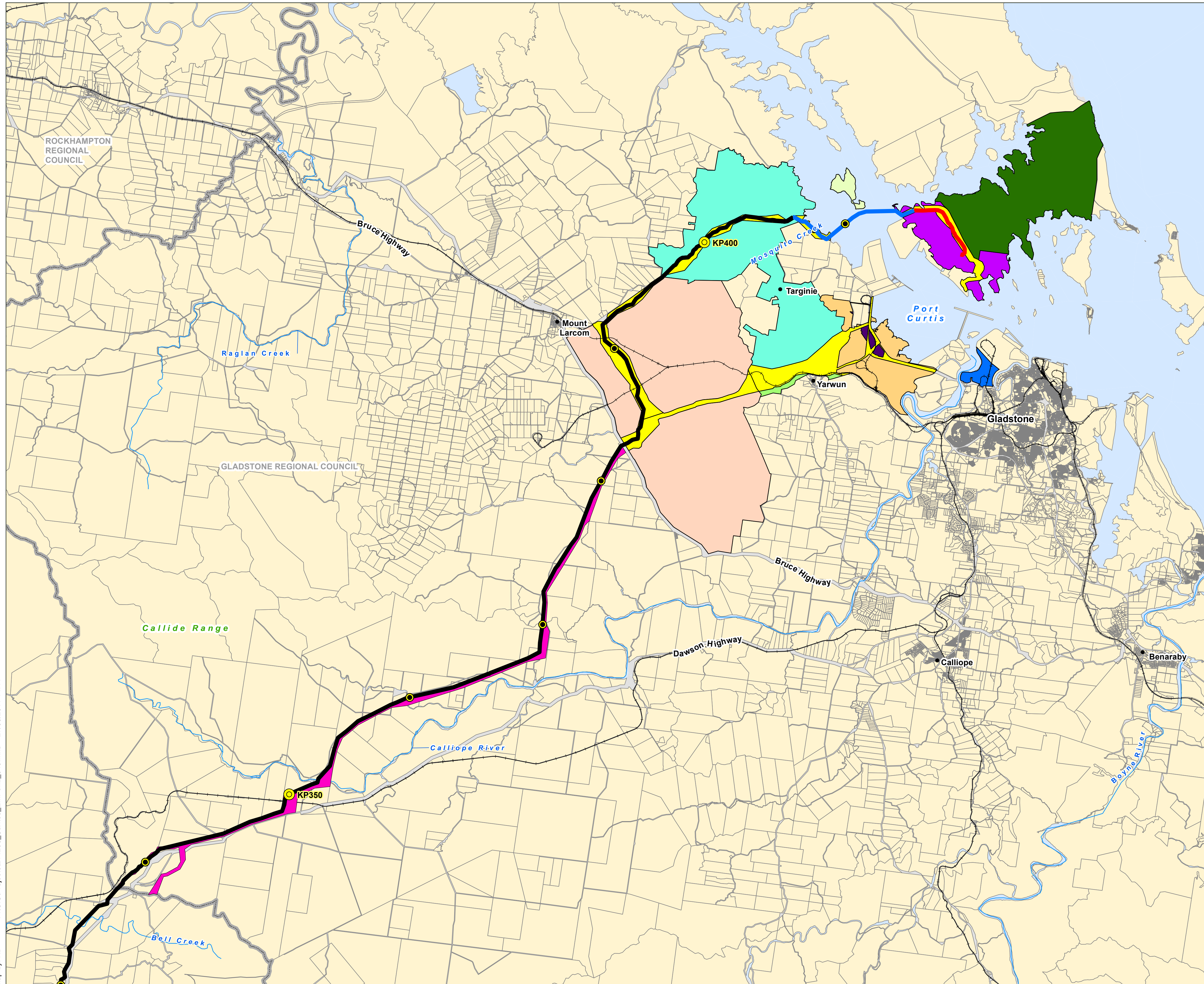
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 Gladstone State Development Area: Santos, Feb 2011

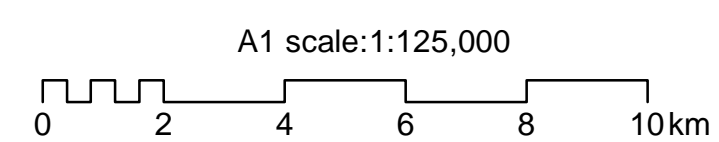
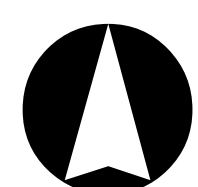
State Development Area Precincts Figure 8.2b

Date: 27/06/2011

Version: c



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Map by: RB



GLNG No: 3381-40-0414
 Coordinate system: GCS GDA 1994

An easement will be established for the Mainland GTP RoW. Other GTP's are also likely to seek similar easements in the vicinity.

8.2.2 Land tenure

The land tenure of the Mainland GTP RoW is shown in Figure 8.1 and summarised in Table 8.2. Land tenure within the RoW is mainly freehold (160 land parcels) and leasehold (32 land parcels), but also includes State Land (one land parcel), Timber Reserve (four land parcels), Reserve (four land parcels), and State Forest (three land parcels). Table 8.2 provides the detail relating to tenure within the Mainland GTP RoW.

Table 8.2 Summary of the proportion of land tenure types within the Mainland GTP RoW

Land tenure	Land parcels	Area (ha)	%
Freehold	160	1067.08	67.8
Leasehold	32	423.40 ¹	26.9
State Land	1	20.87	1.3
Timber Reserve	4	11.6	0.7
Reserve	4	3.80	0.2
State Forest	3	25.16	1.6
Road	N/A	22.1	1.4
Other (inc Santos pipelines)	N/A	1.25	0.1
Total	204	1,575.26	100.0

¹ Rail corridor land is within leasehold land

Table 8.3 Detail of land tenure within the Mainland GTP RoW

KP	Lot/Plan	Tenure	Land ownership/lessee
0	Lot 8 AB200	Freehold	Private landowner
0	Crosses Fairview 192 Access Road (4 crossings)	Road	Santos Pty Ltd
		Water Pipeline (67)	Santos Pty Ltd
		Gas Pipeline (67)	Santos Pty Ltd
		Water Pipeline (67)	Santos Pty Ltd
		Gas Pipeline (67)	Santos Pty Ltd
	Crosses Fairview 192 Access Road	Road	Santos
2	Lot 13 WT18	Freehold	Private landowner
	Crosses Hutton Creek	Untenured Creek	DERM
	Crosses Fairview 191 Access Road	Road	Santos Pty Ltd
		Gas Pipeline (67) (2 crossings)	Santos Pty Ltd
	Crosses Christmas Creek	Untenured Creek	DERM
		Gas Pipeline (67)	Santos Pty Ltd
	Crosses Fairview 190 Access Road	Road	Santos Pty Ltd
		Water Pipeline	Santos Pty Ltd
	Lot 20 WT32	Leasehold	Private landowner

KP	Lot/Plan	Tenure	Land ownership/lessee
	Crosses Fairview Plant Access Road (Basin Road)	Road	Santos Pty Ltd
		Gas Pipeline (48)	Santos Pty Ltd
		Gas Pipeline (47)	Santos Pty Ltd
	Crosses Fairview Plant Access Road (Basin Road)	Road	Santos Pty Ltd
	Crosses Fairview 30 Access Road	Road	Santos Pty Ltd
	Crosses Fairview 63 Access Road	Road	Santos Pty Ltd
		Gas Pipeline (41)	Santos Pty Ltd
11	Lot 4 WT217	Leasehold	Private landowner
14-18	Crosses Fairview 42 Access Road	Road	Santos Pty Ltd
14-18		Gas Pipeline (40)	Santos Pty Ltd
14-18	Crosses Fairview Gathering Line Access Road	Road	Santos Pty Ltd
14-18		Gas Pipeline (39)	Santos Pty Ltd
14-18	Crosses Fairview 57 Access Road	Road	Santos Pty Ltd
14-18		Gas Pipeline (38)	Santos Pty Ltd
	Crosses Fairview Plant Access Road	Optic Fibre Line (CS1-CS2)	Santos Pty Ltd
18	Crosses Fairview Road	Road	Roma Regional Council
14-18		Gas Transmission Pipeline	Jamena
14-18		Powerline (2 Crossings)	Ergon
20	Crosses Baffle Creek	Tenured Creek	DERM
21	Lot 1 WT37	Freehold	Private landowner
22	Crosses Fairview 80 Access Rd	Road	Santos Pty Ltd
23	Crosses Bielba Rd	Road (2 Crossings)	Roma Regional Council
23		Gas Pipeline (16)	Santos Pty Ltd
23	Crosses Bielba Rd	Road	Roma Regional Council
26	Crosses Fairview 19 Access Road	Road (2 Crossings)	Santos Pty Ltd
30	Crosses Dawson River	Tenured River	DERM
30	Lot 807 PH1979	Crown land	State Owned Land
31	Crosses Gratz Gully (2 Crossings)	Untenured Creek	DERM
35	Crosses Fairview 33 Access Road	Road	Santos Pty Ltd
37	Lot 8 TR23	Freehold	Private landowner
39	Crosses Fairview Access Road	Road	Santos Pty Ltd
41	Lot 7 TR22	Freehold	Private landowner
42	Crosses Fairview 54 Access Road	Road	Santos Pty Ltd
46	Lot 6 TR20	Freehold	Private landowner
46	Crosses Bully Frog Creek	Untenured Creek	DERM
53	Lot 5 TR18	Freehold	Private landowner
55	Crosses Arcadia Branch 1 Access Road	Un-gazetted Road	Santos Pty Ltd

KP	Lot/Plan	Tenure	Land ownership/lessee
58	Lot 9 TR17	Freehold	Private landowner
61	Crosses unnamed creek	Untenured creek (2 crossings)	DERM
62	Crosses Ironbark Creek	Untenured creek	DERM
63	Lot 8 TR15	Freehold	Private landowner
67	Crosses Hardenley 1 Access Road	Road	Santos Pty Ltd
68	Lot 7 TR 39	Freehold	Private landowner
71	Lot 6 TR 11	Freehold	Private landowner
81	Lot 3 TR 31	Freehold	Private landowner
84	Lot 2 TR 30	Freehold	Private landowner
	Crosses Powerline	Powerline	
86	Crosses Membrane Creek	Untenured Creek	DERM
88	Lot 4 TR 32	Freehold	Private landowner
92	Lot 5 TR 33	Freehold	Private landowner
	Lot 6 TR 34	Freehold	Private landowner
99	Lot 13 CUE94	Leasehold	Private lessee
	Lot 15 CUE93	Leasehold	Private lessee
102	Lot 2 CUE92	Leasehold	Private lessee
	Crosses Powerline	Powerline (2 Crossings)	Private landowner
108	Crosses Clematis Creek	Untenured Creek	Private landowner
	Crosses Private Access Road		CHRC
110	Lot 1 CUE 95	Leasehold	Private lessee
111	Crosses May Creek	Untenured Creek	DERM
	Lot 7 CUR91	Leasehold	Private lessee
	Lot 29 FTY1847	State Owned Land	EPA
		Gas Pipeline (QLD)	
	Lot 7 CUE91	Leasehold	Private lessee
	Lot 29 FTY1847	State Owned land	EPA
		Gas Pipeline (QLD)	
147	Lot 7 SP142673	State owned land	EPA
	Lot 29 FTY1847	State owned land	EPA
	Lots 4 and 6 on SP 142673	Leasehold	Private lessee
155	Lot 1 BH 240	Leasehold	Private lessee
	Crosses unnamed Road	Road	CHRC
167	Lot 2 RP 912777	Freehold	Private landowner
171	Lot 16 BH 269	Freehold	Private landowner
	Crosses Fairfield Road	Road	CHRC
174	Lot 28 BH 244	Leasehold	Private lessee
	Crosses Unnamed Road	Road	CHRC
	Lot 15 BH 243	Freehold	Private landowner

KP	Lot/Plan	Tenure	Land ownership/lessee
174	Crosses Dawson Highway	Road	DTMR
	Lot 1 BH 240	Leasehold	Private lessee
	Lot 36 BH 243	Freehold	Private landowner
177	Lot 27 RP 911528	Freehold	Private landowner
	Crosses Prospect Creek	Untenured Creek	DERM
180	Lot 28 RP 911528	Freehold	Private landowner
182	Lot 14 BH 207	Freehold	Private landowner
183	Crosses Zamia Creek	Untenured Creek	CHRC/DERM
189	Lot 5 BH 138	Leasehold	Private lessee
190	Lot 9 BH 97	Freehold	Private landowner
193	Lot 1 SP 136872	Freehold	Private landowner
194	Lot 13 RP 620842	Freehold	Private landowner
199	Crosses Oomabeer Road	Road	DERM
200	Lot 10 BH 223	Freehold	Private landowner
207	Lot 1 SP 197365	Freehold	Private landowner
	Crosses Conciliation Creek	Tenured Creek	CHRC/DERM
	Lot 5 KM65	Freehold	Private landowner
207	Crosses unnamed Road	Road	CHRC
215	Crosses Brulga Gully	Untenured Creek	DERM
215	Lot 4 KM74	Freehold	Private landowner
220	Crosses Mimosa Creek	Untenured Creek	CHRC/DERM
222	Crosses Bears Lagoon Road	Road	CHRC
224	Lot 8 KM87	Freehold	Private landowner
	Crosses Denby Road	Road	Banana Shire Council (BSC)
	Crosses Unnamed Road	Road	BSC
227	Lot 7 KM142	Freehold	Private landowner
	Crosses Denby Creek	Untenured Creek	DERM/BSC
	Crosses Dawson River	Tenured Creek	DERM/BSC
	Lot 46 FN 191		
	Lot 16 FN 506	Freehold	Private landowner
	Crosses Back Creek	Untenured Creek	DERM/BSC
	Lot 46 on FN 191		
	Lot 901793	Freehold	Private landowner
	Crosses Unnamed Road	Road	BSC
234	Lot 16 FN506	Freehold	Private landowner
	Crosses Unnamed Road	Road	BSC
	Crosses Disused Railway	Railway	Queensland Rail
	Crosses Moura-Bindaree Road	Road	BSC
238	Lot 38 FN 306	Freehold	Private landowner

KP	Lot/Plan	Tenure	Land ownership/lessee
	Crosses Banana-Mungi Road	Road	BSC
238	Lot 37 FN 506	Freehold	Private landowner
	Crosses Kianga Creek	Untenured Creek	DERM
	Lot 31 FN 193	Leasehold	Private lessee
		Gas Pipeline (2 Crossings)	Private owner
	Crosses Moura – Baralaba Road	Road	BSC
243	Lot 3 FN 207	Leasehold	Private lessee
	Crosses Back Creek	Freehold	Private landowner
248	Lot 10 FN 207	Freehold	Private landowner
	Crosses Unnamed Road	Road	BSC
249	Lot 2 FN 197	Leasehold	Private Lessee
		Powerline	Powerlink
251	Lot 49 FN352	Leasehold	Private Lessee
	Crosses Banana Creek	Tenured Creek	DERM/BSC
253	Lot 39 FN305	Leasehold	Private Lessee
254	Lot 40 FN305	Freehold	Private landowner
256	Crosses Unnamed Road	Road	BSC
256	Lot 21 FN306	Freehold	Private landowner
	Crosses Baralaba – Banana Road	Road	BSC
258	Lot 26 FN302	Leasehold	Private lessee
259	Lot 25 FN302	Powerlines	Private landowner
260	Lot 22 FN301	Freehold	Private landowner
263	Lot 5 FN10	Freehold	Private landowner
	Crosses Police Camp Creek	Tenured Creek	DERM/BSC
264	Lot 4 FN6	Freehold	Private landowner
264	Lot 3 FER4025	Freehold	Private landowner
268	Lot 20 FN491	Freehold	Private landowner
	Crosses Leichardt Highway	Road	DTMR
269	Lot 34 RP 621029	Freehold	Private landowner
270	Crosses Police Camp Creek	Untenured Creek	DERM/BSC
270	Crosses Belideen Defense Road	Road	BSC
270	Lot 2 SP 122586	Freehold	Private landowner
271	Crosses Unnamed Road	Road	BSC
275	Lot 57 PM83	Leasehold	Private Lessee
279	Lot 41 SP 224438	Freehold	Private landowner
280	Crosses Selheim Creek	Untenured Creek	DERM/BSC
281	Lot 40 SP 224438	Freehold	Private landowner
283	Lot 61 PM224	Freehold	Private landowner
283	Crosses Johnston Parry Road	Road	BSC

KP	Lot/Plan	Tenure	Land ownership/lessee
284	Lot 91 PM 224	Freehold	Private landowner
285	Belldeen Greycliffe Road	Road	BSC
285	Lot 81 PM222	Freehold	Private landowner
285	Crosses Neville Creek	Untenured Creek	BSC
287	Lot 82 PM222	Freehold	Private landowner
	Crosses Moura Railway	Railway	Queensland Rail
289	Lot 84 PM207	Freehold	Private landowner
290	Lot 75 PM207	Freehold	Private landowner
292	Crosses Prospect Creek- Goovigen Road	Road	BSC
292	Powerline	Powerline	Ergon
293	Lot 1 RN347	Freehold	Private landowner
	Powerline	Powerline	Powerlink
295	Lot 11 RP 618897	Freehold	Private landowner
296	Lots 24,25,26 RN 347	Freehold	Private landowner
296	Crosses Kroombit Creek	Untenured Creek	DERM/BSC
297	Lot 23 RN347	Freehold	Private landowner
297	Crosses Burnett Highway	Road	DTMR
	Crosses Callide Creek	Untenured creek	DERM/BSC
298	Lot 31 RN349	Freehold	Private landowner
298	Lot 32 RN1155	Freehold	Private landowner
299	Lot 138 RN 976	Freehold	Private landowner
	Lot 139 RN350	Leasehold	Private lessee
299	Crosses Blacks Road	Road	BSC
300	Lot 1 RP 620969	Freehold	Private landowner
300	Lot 50 RP 620969	Freehold	Private landowner
300	Lot 48/49 RN350	Freehold	Private landowner
300	Crosses Callide Creek	Untenured Creek	DERM/BSC
301	Crosses Jambin Dakenba Road	Road	BSC
	Crosses Railway	Railway	Queensland Rail
301	Lot 62 RN1330	Freehold	Private landowner
302	Lot 63 RN1330	Freehold	Private landowner
303	Lot 64 RN373	Freehold	Private landowner
	Crosses Mallinsons Road	Road	BSC
305	Lot 77 SP 163782	Freehold	Private landowner
306	Crosses Callide-Kilburnie Road	Road	BSC
307/306	Lot 83/84 RN426	Freehold	Private landowner
309	Lot 1 RP 616095	Freehold	Private landowner
310	Lot 1 RP 618390	Freehold	Private landowner

KP	Lot/Plan	Tenure	Land ownership/lessee
310	Powerline	Easement	Qld Electricity Transmission Corp Ltd
310	Powerline	Powerline	Powerlink
	Lot 170 FTY1843	State owned land	EPA
311	Crosses Argoon Kilburnie Road	Road	BSC
314	Crosses Unnamed Road	Road	BSC
316	Lot 8 RN1580	Leasehold	Private lessee
316	Crosses Unnamed Road	Road	BSC
327-329	Lots 7-9 RP 843126	Freehold	Private landowners
330	Lots 5/6 RP 843128	Freehold	Private landowners
330	Crosses Unnamed Road	Road	BSC
331/332	Lots 1-4 RP 843125	Freehold	Private landowners
333	Lot 41 RN 800347	Freehold	Private landowner
333	Crosses Unnamed Road	Road	BSC
334	Crosses Bell Creek	Untenured Creek	DERM/BSC
336	Crosses Inverness Road	Road	BSC
337	Lot 12 SP 199385	Leasehold	Private lessee
338		Gas Pipeline	Jemena
338	Lot 11 SP 199386	Leasehold	Private lessee
341	Lot 13 CTN301	Freehold	Private landowner
344	Lot 12 CTN301	Freehold	Private landowner
344	Powerline	Powerline	Qld Electricity Transmission Corp Ltd
345	Crosses Unnamed Road	Road	GRC
345	Lot 25 CTN 406	State owned land	DERM
345	Lot 4 CTN406	Freehold	Private landowner
346	Lot 412 CL40158	Freehold	Private landowner
347	Lot 12 SP 199383	Freehold	Private landowner
348	Lot 13 SP 200915	Freehold	Private landowner
349	Lot 1 RP 616641	Freehold	Private landowner
	Crosses Railway	Railway	Queensland Rail
350	Lot 7 RP 609065	Freehold	Private landowner
351	Crosses Duckhole Creek Road	Road	GRC
351	Lot 23 CTN 1233	Freehold	Private landowner
352	Crosses Calliope River	Tenured River	DERM
353	Lot 19 CTN 345	Freehold	Private landowner
355	Lot 18 CTN344	Freehold	Private landowner
356	Lot 1 RP 606302	Freehold	Private landowner
358	Crosses Unnamed Road	Road	GRC
358	Lot 1 RP 865974	Freehold	Private landowner

KP	Lot/Plan	Tenure	Land ownership/lessee
359	Crosses Unnamed Road	Road	GRC
359	Lot 16 CTN344	Freehold	Private landowner
360	Crosses Harper Creek	Tenured Creek	DERM
361/362	Lot 217/218 CL4081	Freehold	Private landowner
363	Lot 1 CL4032	Freehold	Private landowner
363	Crosses Unnamed Road	Road	GRC
364	Lot 217 CL4081	Freehold	Private landowner
364	Crosses Unnamed Road	Road	GRC
364	Lot 269 CL4095	Freehold	Private landowner
365	Crosses Mount Alma Road	Road	Private landowner
	Crosses Alarm Creek	Untenured creek	DERM
367	Crosses Unnamed Road	Road	GRC
367	Lot 477 CL40223	Freehold	Private landowner
368	Lot 219 CL40301	Freehold	Private landowner
		Gas Pipeline	Jemena
368	Crosses Sandy Creek	Untenured creek	DERM
	Lot 477 CL40223	Freehold	Private landowner
370	Lot 6 CTN812615	Freehold	Private landowner
370	Lot 4 RP 860093	Freehold	Private landowner
370	Crosses Mount Alma Road	Road	GRC
371	Lot 49 CTN 512	Freehold	Private landowner
372	Lot 48 CTN 512	Freehold	Private landowner
374	Whycheproof Road	Road	GRC
374	Lot 419 CL40215	Freehold	Private landowner
375	Crosses Gravel Creek	Untenured Creek	DERM
	Powerline	Powerline	Qld Electricity Transmission Corporation Ltd
378	Crosses Larcom Creek	Tenured Creek	DERM
378	Lot 524 CL40243	Freehold	Private landowner
380	Lot 525 CL40243	Freehold	Private landowner
380	Crosses Mount Alma Road	Road	GRC
	Powerline	Powerline	Qld Electricity Transmission Corporation Ltd
381	Lot 67 CL40347	Freehold	Private landowner
382	Crosses Unnamed Road	Road	GRC
382	Lot 3 RP801363	Freehold	Private landowner
382	Powerline	Powerline	Ergon
383	Crosses Bruce Highway	Road	DTMR
383	Lot 9 SP200837	State Owned Land	MIDQ

KP	Lot/Plan	Tenure	Land ownership/lessee
		Gas Pipeline	Jemena
384	Crosses Larcom Creek	Tenured Creek	DERM
385	Lot 8 SP200847	State owned land	MIDQ
350	Disused Slurry Pipeline	Pipeline	Cement Australia
387	Lot 201 SP116496	Freehold	Private landowner
	Crosses Railway	Railway	Queensland Rail
389	Lot 4 RP620657	Freehold	Private landowner
391	Crosses Gladstone – Mt Larcom Road	Road	
	Crosses Railway	Railway	Queensland Rail
392	Lot 2 SP157677	Freehold	GRC
394	Powerline	Powerline	Qld Electricity Transmission Corporation Ltd
396	Crosses Cullens Road	Road	GRC
398	Lot 45 RP894241	State owned land	Coordinator General
401/400	Lots 1/2 SP108915	State owned land	Coordinator General
401	Lot 86 DS636	State owned land	Coordinator General
402	Lots 1 and 3 MPH14076	State owned land	Coordinator General
403	Lot 2 DS725	State owned land	Coordinator General
	Crosses Targinie Road	Road	GRC
403	Lot 2 RP897093	State owned land	Coordinator General
404	Lot 1 MPH34582	State owned land	Coordinator General
404	Crosses Flinders Road	Road	GRC
404	Lot 2 MPH34582	State owned land	Coordinator General
405	Lot 137 FTY1831	State owned land	
405	Lot 1 RP612108	Freehold	Private landowner

8.2.3 Resource tenure

The resource tenures relevant to the Mainland GTP RoW include mining leases, mineral development leases, exploration permits for coal and minerals and petroleum leases and permits (refer Chapter 1 and Chapter 2 for legislation relevant to resource tenures and their relevance to the Project). Table 8.4 provides a summary of the area of each resource tenure that the Mainland GTP RoW crosses. The mining and petroleum leases and permits are shown in Figure 8.3a to Figure 8.3e noting that there is some area of overlap between each lease and permit area.

Table 8.4 Summary of the proportion of resource tenure types within the Mainland GTP RoW

Resource tenure	Area (ha)	% of RoW Area ²
Mining Leases	9.72	0.6
Mineral Development Leases	39.04	2.5
Exploration Permits (Coal)	1203.25	76.4

² Total RoW area is 1,575.26 ha

Resource tenure	Area (ha)	% of RoW Area ²
Exploration Permits (Minerals)	252.43	16.0
Exploration Permits (Petroleum)	670.50	42.6
Petroleum Leases	336.80	21.4

Mining leases

The Mainland GTP RoW crosses a mining lease near Banana at KP 252. Other mining leases are located near to the Mainland GTP RoW at KP 311, but the RoW does not cross the leases.

Mineral Development Lease

The Mainland GTP RoW crosses two applications for mineral development leases near Callide at KP 310 and mineral development leases have been granted near KP403 to KP406 near Gladstone.

Exploration Permits (Coal)

Exploration permits (Coal) have been granted along much of the length of the Mainland GTP RoW from KP 0 to KP 150. Currently there are applications pending from KP 160 to KP 211. From KP 230 to KP 340 there are exploration permits (Coal) along the length of the Mainland GTP RoW. At KP 340 north-east of Biloela and through to Gladstone there are no exploration permits (Coal) across the Mainland GTP RoW.

Exploration Permits (Minerals)

Exploration permits (Minerals) are located between KP250 and KP 406 along the Mainland GTP RoW both granted and under application. There are a smaller number of exploration permits (Minerals) along the remainder of the RoW such as those at its origin (KP 0) near Injune.

Exploration Permits (Petroleum)

Exploration permits (Petroleum), principally between KP 50 and KP 274, affect a significant proportion of the Mainland GTP RoW.

Petroleum leases

The Mainland GTP RoW will cross petroleum leases from KP 40 to KP 111 and a smaller area near KP 244. Petroleum leases are not encountered along the remainder of the Mainland GTP RoW.

8.2.4 Land use

The Mainland GTP RoW passes through approximately 1,575 ha of land. Land uses that the Mainland GTP RoW traverse are identified in Figure 8.4 and summarised in Table 8.5. The predominant existing land use is agriculture and a small area of forestry. Future land use may change in some areas to industrial as a consequence of the resource tenure approvals, applications within and near to the RoW and from development in the GSDA.

Table 8.5 Summary of the proportions of different land uses within the Mainland GTP RoW

Land use	Area (ha)	%
Agriculture	1527.45	97.0
Forestry	37.04	2.4

Land use	Area (ha)	%
Industrial	0	0
Commercial	0	0
Residential	0	0
Conservation	0	0
Watercourses	1.24	<1%
Other	9.54	<1%

Agriculture

The majority (97%) of the Mainland GTP RoW is identified as agricultural land. These agricultural uses include grazing natural vegetation for cattle and other livestock and cropping.

Forestry

The Mainland GTP RoW passes through the following State Forests and Timber Reserve (refer Figure 8.5):

- Expedition State Forest (KP 140 to KP 150)
- Targinie State Forest (KP 405)
- Callide Timber Reserve (KP 345)

Industrial

The Mainland GTP RoW, as discussed in Section 8.2.3, crosses through a number of resource tenures that are likely to lead to future industrial land use, which includes mining, petroleum and exploration permits.

8.2.5 Population centres and nearby residences

Table 8.6 provides a summary of the main population centres near to the Mainland GTP RoW. Gladstone is the largest population centre, with a number of secondary centres in the outlying rural areas namely; Beecher, Mount Larcom, Thangool, Biloela, Banana, Baralaba, Rolleston, Wyseby and Injune.

There are 29 residential dwellings within a 5 km wide corridor along the Mainland GTP RoW (URS, 2009).

Table 8.6 Population of mainland towns in the vicinity of the Mainland GTP RoW

Town	Population
Gladstone	28,808
Beecher	784
Mount Larcom	253
Thangool	339
Biloela	5,752
Banana	13,361
Baralaba	259
Rolleston	219
Wyseby	390

Town	Population
Injune	362

Source: Australian Bureau of Statistics, *Census 2006*

8.2.6 Infrastructure crossings

The Mainland GTP has multiple infrastructure crossings (refer Figure 8.6). These include rail, road and powerlines. In summary, the affected infrastructure is:

- Queensland Rail – six crossings of rail lines
- Department of Transport and Main Roads – five crossings of State Controlled Roads
- Gladstone Regional Council – 21 crossings of roads
- Banana Shire Council – 70 crossings of roads
- Central Highland Regional Council – 17 crossings of roads
- Maranoa Regional Council – nine crossings of roads
- Powerlink – powerlines – seven crossings (KP 249, KP 293, KP 310, KP 311, KP 344, KP 377, KP 394)
- Stock routes
- Powerline – not an easement
- Gladstone Area Water Board water pipeline
- Jemena gas pipeline

The Mainland GTP RoW passes near to a number of air strips as shown in Figure 8.6.

8.2.7 Easements and major infrastructure

The Mainland GTP RoW will cross the following major infrastructure:

- Bruce Highway
- Other state-controlled roads
- Operational rail corridor
- Gladstone Area Water Board infrastructure

The following infrastructure is located near to the Mainland GTP RoW:

- Callide (13 km) and Gladstone Power Stations (15 km)
- Jemena gas pipeline

8.2.8 Roads

The Mainland GTP RoW crosses a number of major roads (eg Bruce Highway), local roads, and tracks. These are further illustrated in Figure 8.6.

8.2.9 Stock routes

The Mainland GTP RoW has six stock routes that cross or are located near to the Mainland GTP RoW. Between KP 145 and 147 the Mainland GTP will cross a major stock route refer Figure 8.6. Other crossings occur at KP 223, KP 258, KP 270 and between KP 311 and KP 317. The final stock route runs alongside the Mainland GTP RoW from KP 327 to KP 349.

According to the DERM mapping of the Queensland Stock Routes and the *Stock Route Strategy 2009-2014*, these routes are also reserved for additional purposes such as roads, power lines, and gas lines.



Mainland GTP EM Plan

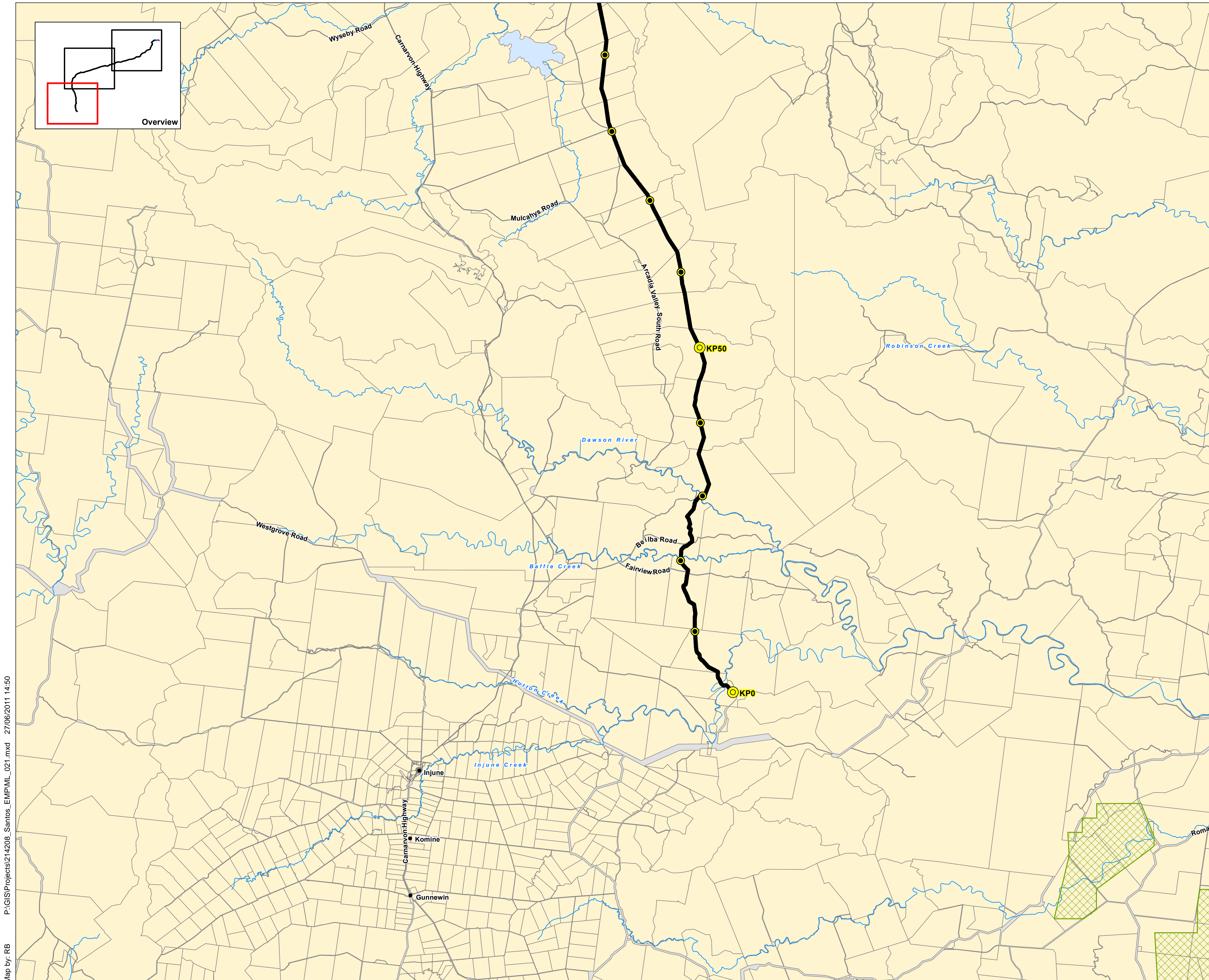
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 - Mainland GTP EM Plan
 - Marine Crossing GTP EM Plan
 - Curtis Island GTP EM Plan
- Kilometre Post Distance Marker
 - 50km
 - 10km
- Mining Lease Status
 - Granted
 - Application
 - Cadastre
 - Rail
 - Watercourse
 - Major Road

Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Cadastre: Department of Environment and Resource Management, Jun 2011.
 Resource Tenure: Department of Mines and Energy, Feb 2011.

Mining Tenure- Mining Lease Figure 8.3a (Page 1 of 3)

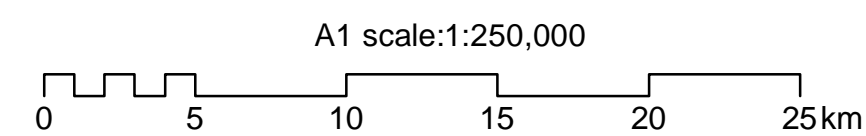
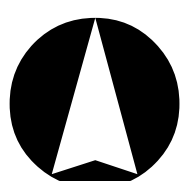
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Map by: RB



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 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

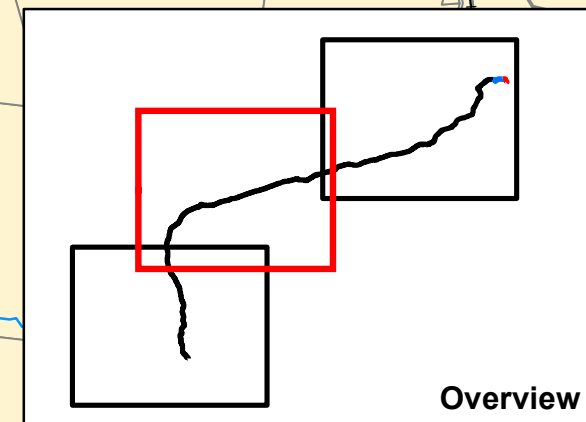
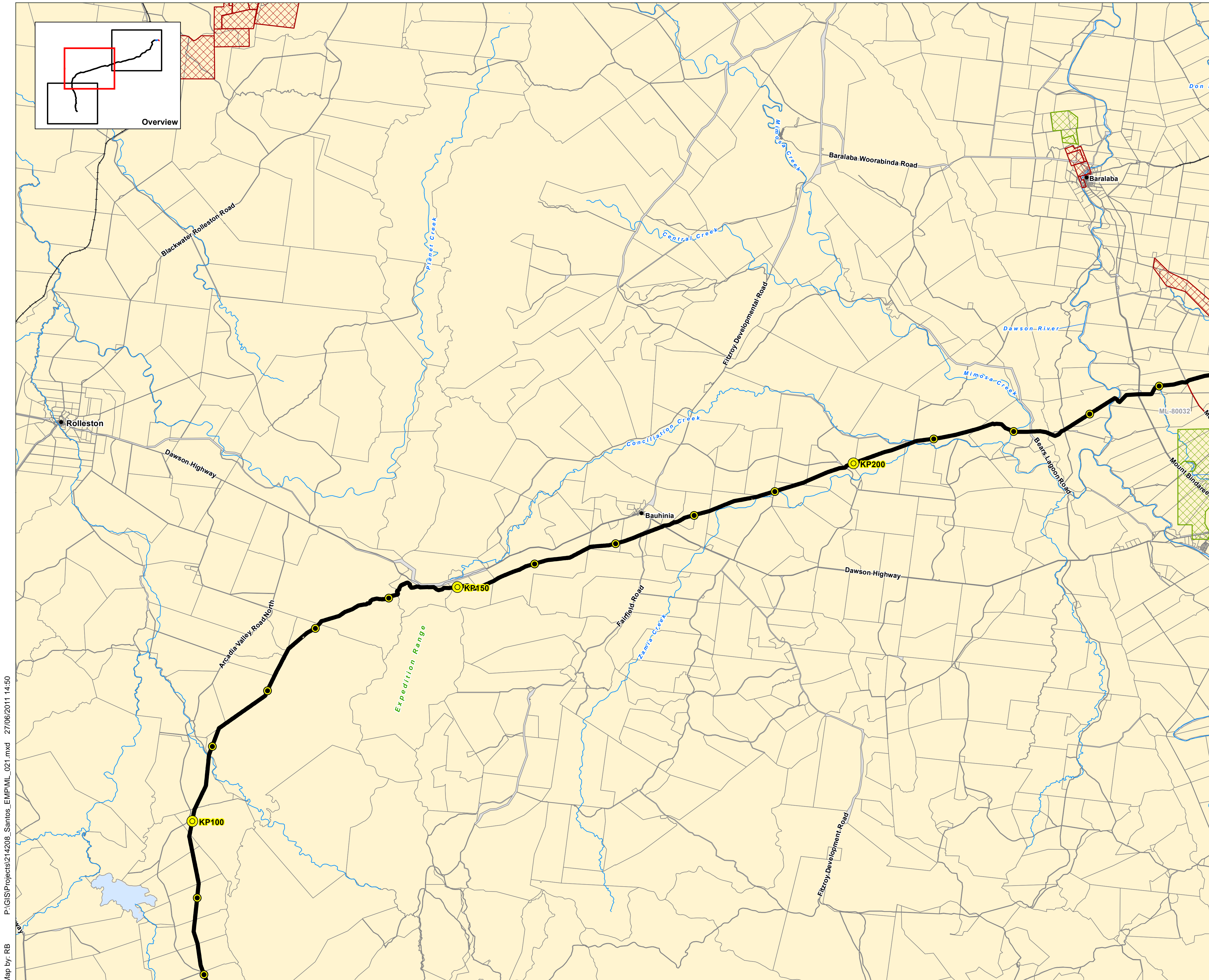
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Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
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Mining Tenure- Mining Lease Figure 8.3a (Page 2 of 3)

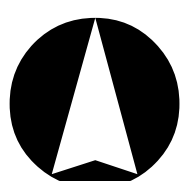
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GLNG No: 3381-40-0415
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Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

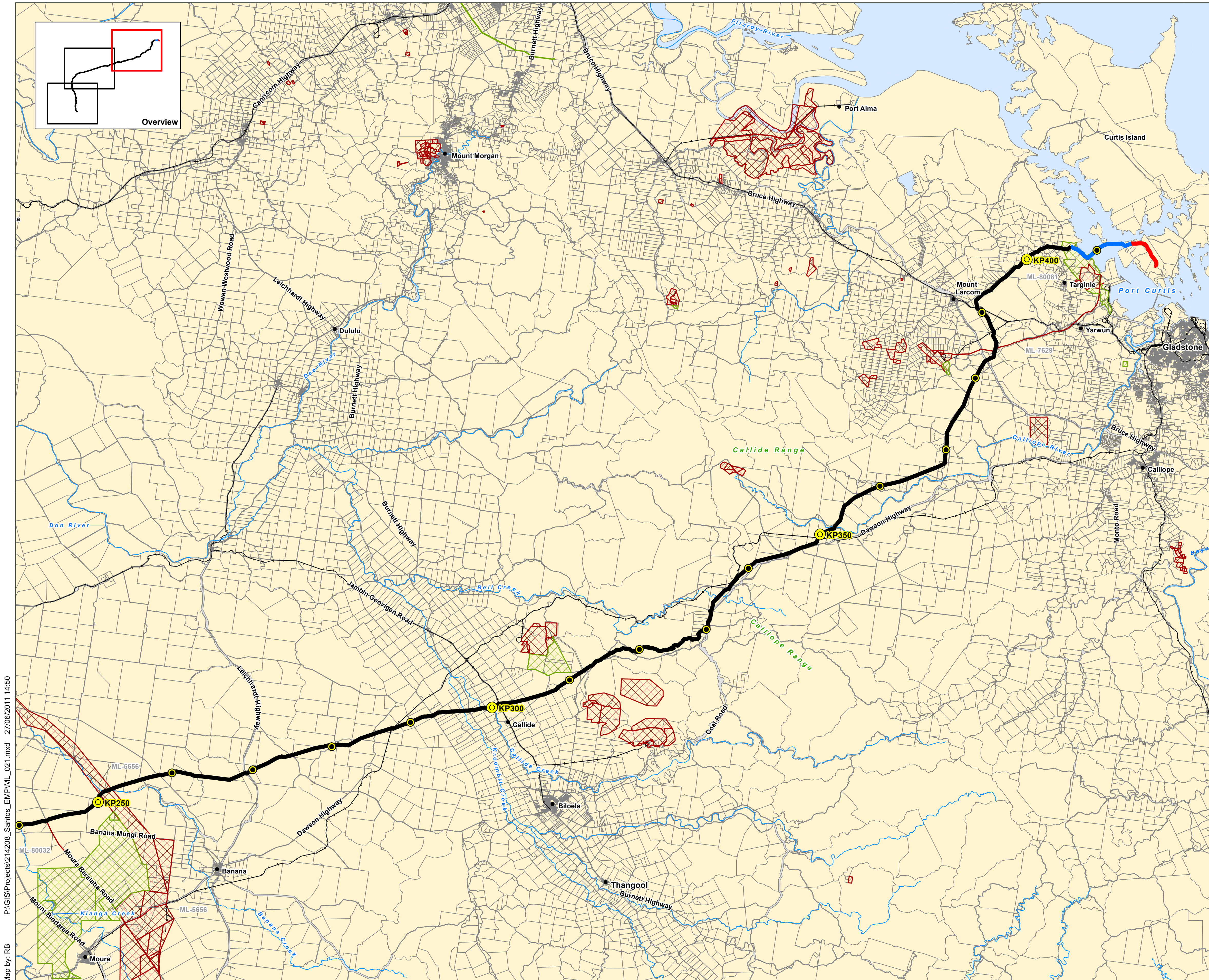
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Mining Lease Status

- Granted
- Application
- Cadastre

- Rail
- Watercourse
- Major Road

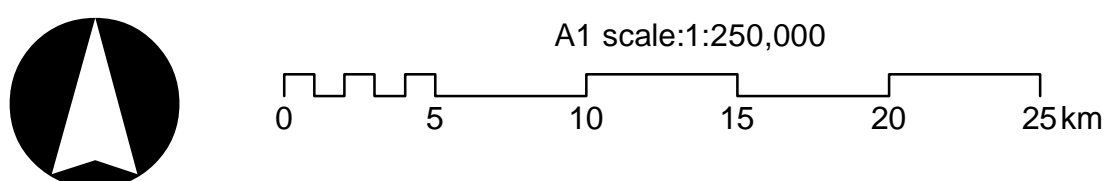


Source:
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 Cadastre: Department of Environment and Resource Management, Jun 2011.
 Resource Tenure: Department of Mines and Energy, Feb 2011.

Mining Tenure- Mining Lease
Figure 8.3a (Page 3 of 3)

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Mainland GTP EM Plan

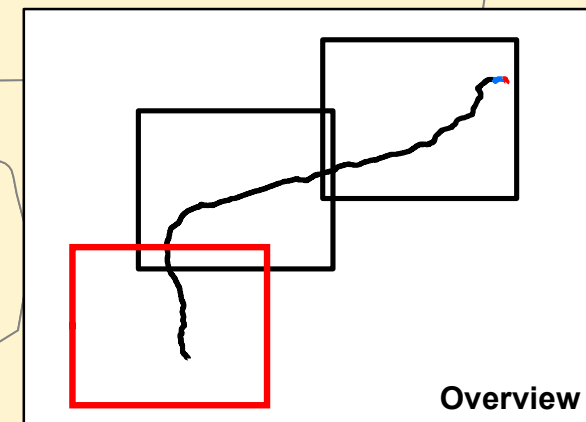
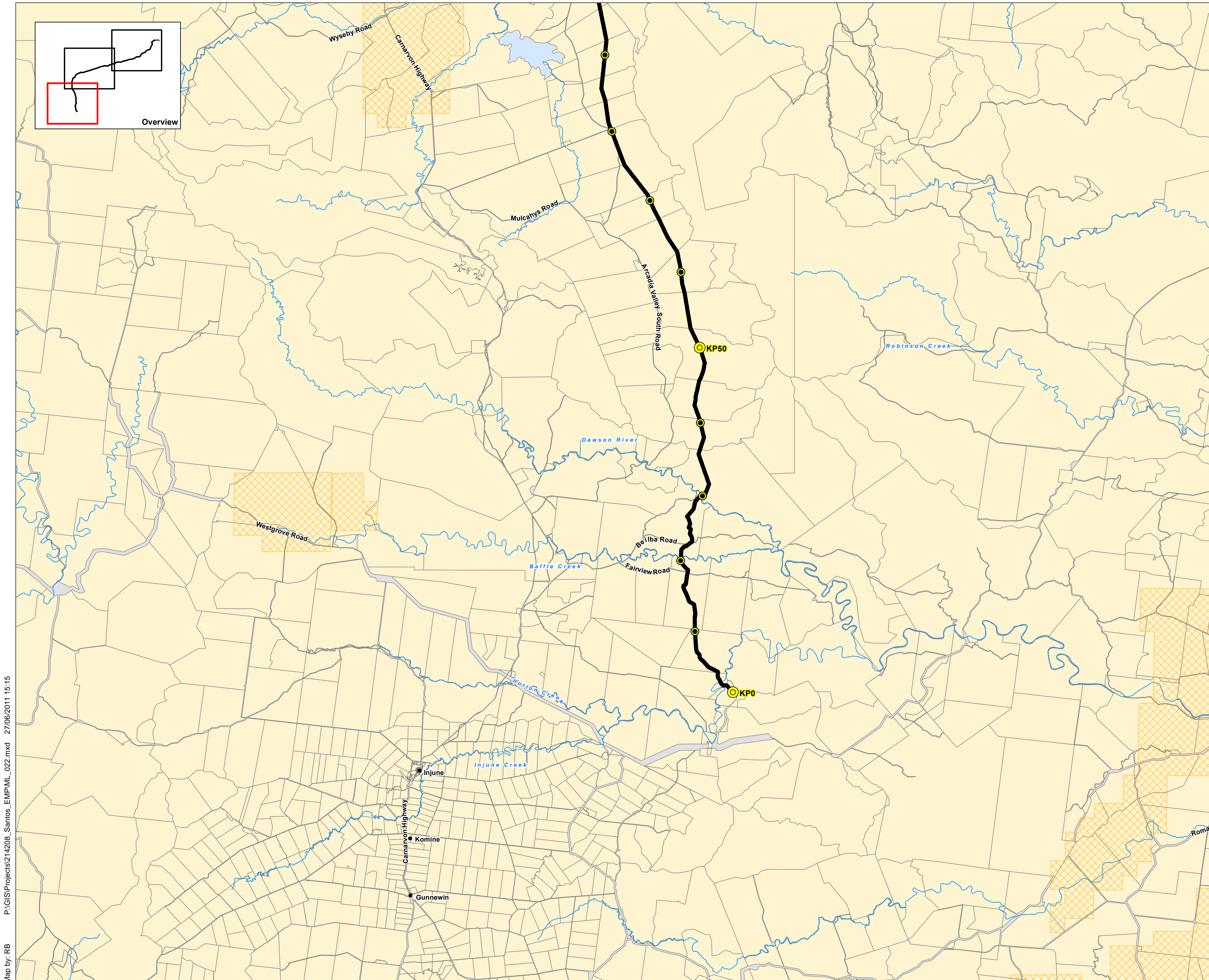
- Gas Transmission Pipeline (GTP)
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- Kilometre Post Distance Marker
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 - 10km
- Mineral Development Licence Status
- Granted
 - Application
 - Cadastre
 - Rail
 - Watercourse
 - Major Road

Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Cadastre: Department of Environment and Resource Management, Jun 2011.
 Resource Tenure: Department of Mines and Energy, Feb 2011.

Mining Tenure- Mineral Development Licence Figure 8.3b (Page 1 of 3)

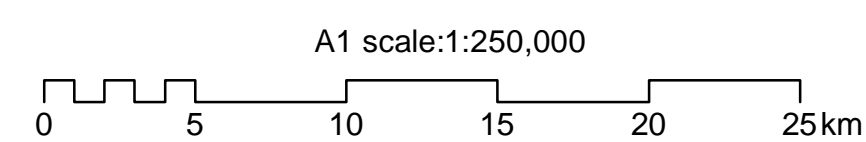
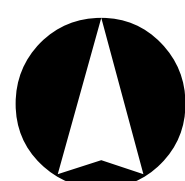
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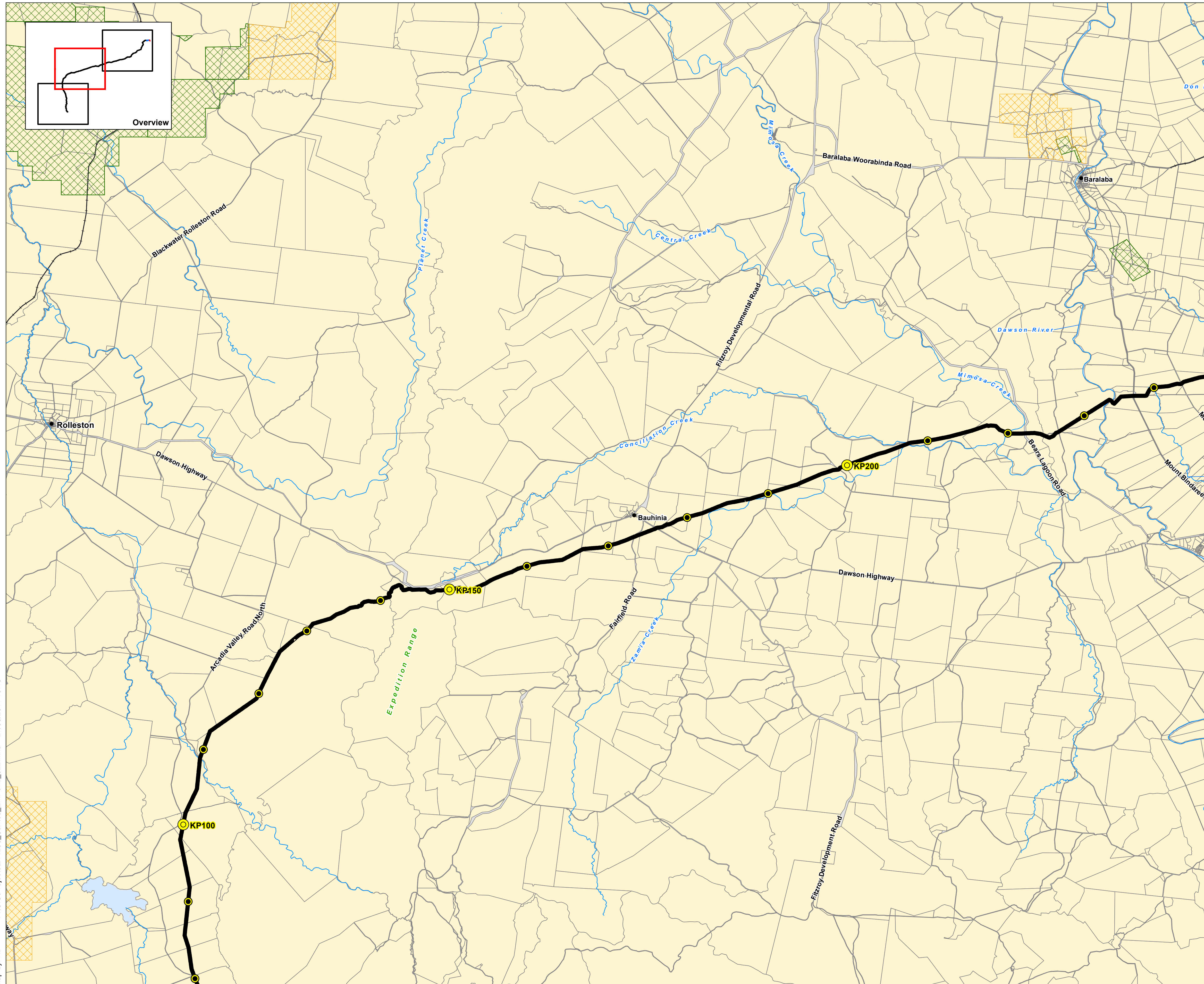
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 - Watercourse
 - Major Road

Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Cadastre: Department of Environment and Resource Management, Jun 2011.
 Resource Tenure: Department of Mines and Energy, Feb 2011.

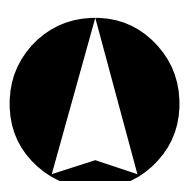
Mining Tenure- Mineral Development Licence Figure 8.3b (Page 2 of 3)

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 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

- Gas Transmission Pipeline (GTP)
 - Mainland GTP EM Plan
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- Rail
- Watercourse
- Major Road

Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Cadastre: Department of Environment and Resource Management, Jun 2011.
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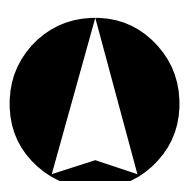
Mining Tenure- Mineral Development Licence Figure 8.3b (Page 3 of 3)

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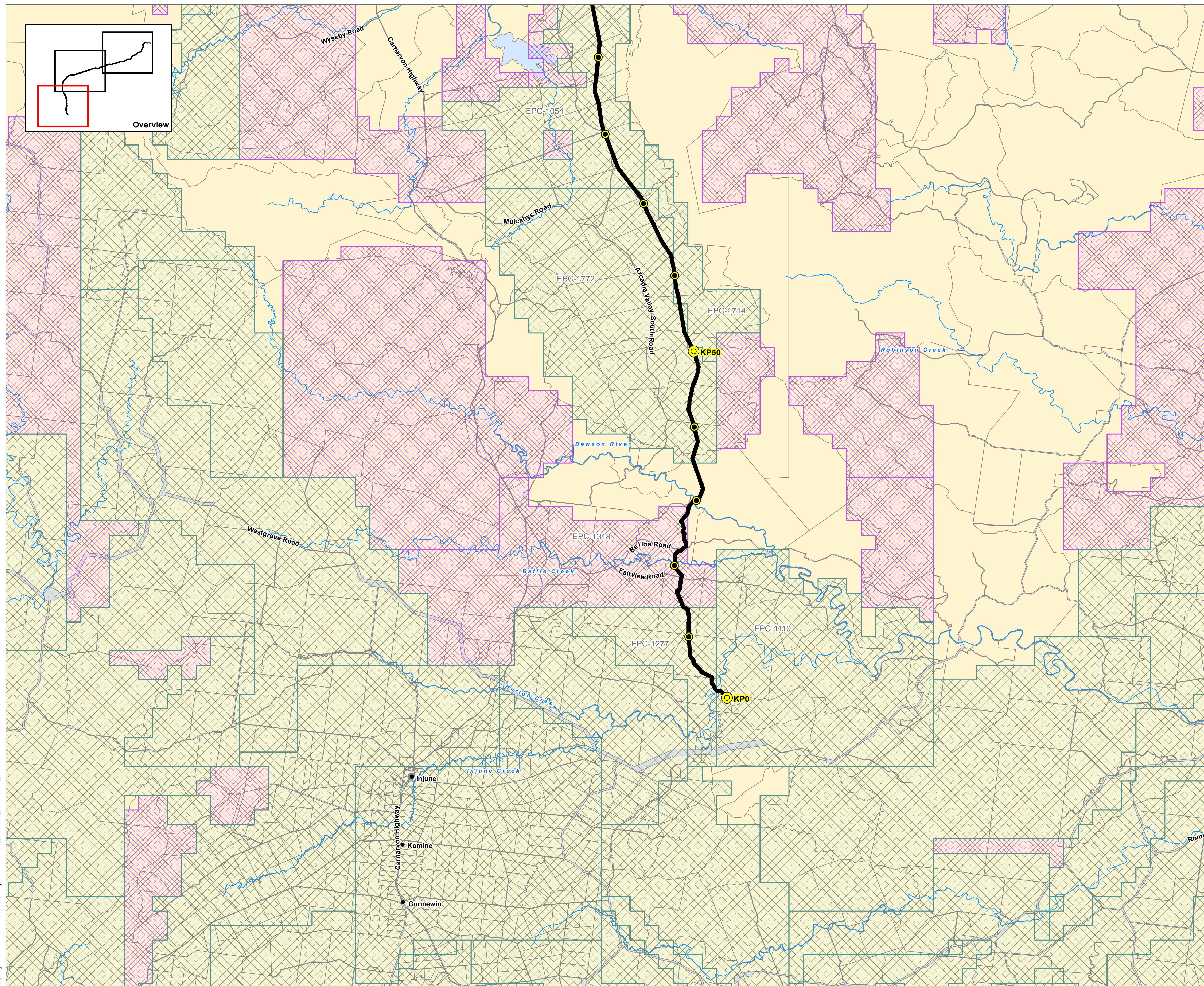
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- Exploration Permit for Coal Status
 - Granted
 - Application
 - Cadastre
 - Rail
 - Watercourse
 - Major Road

Source:
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Mining Tenure- Exploration Permit (Coal) Figure 8.3c (Page 1 of 3)

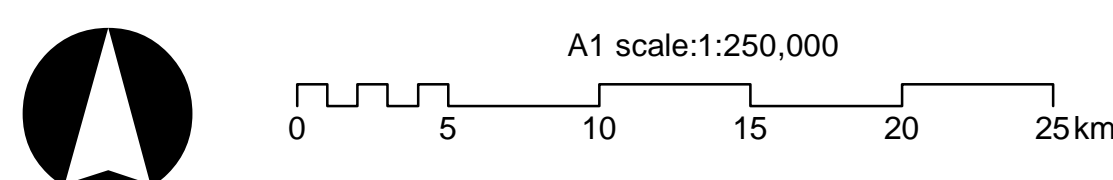
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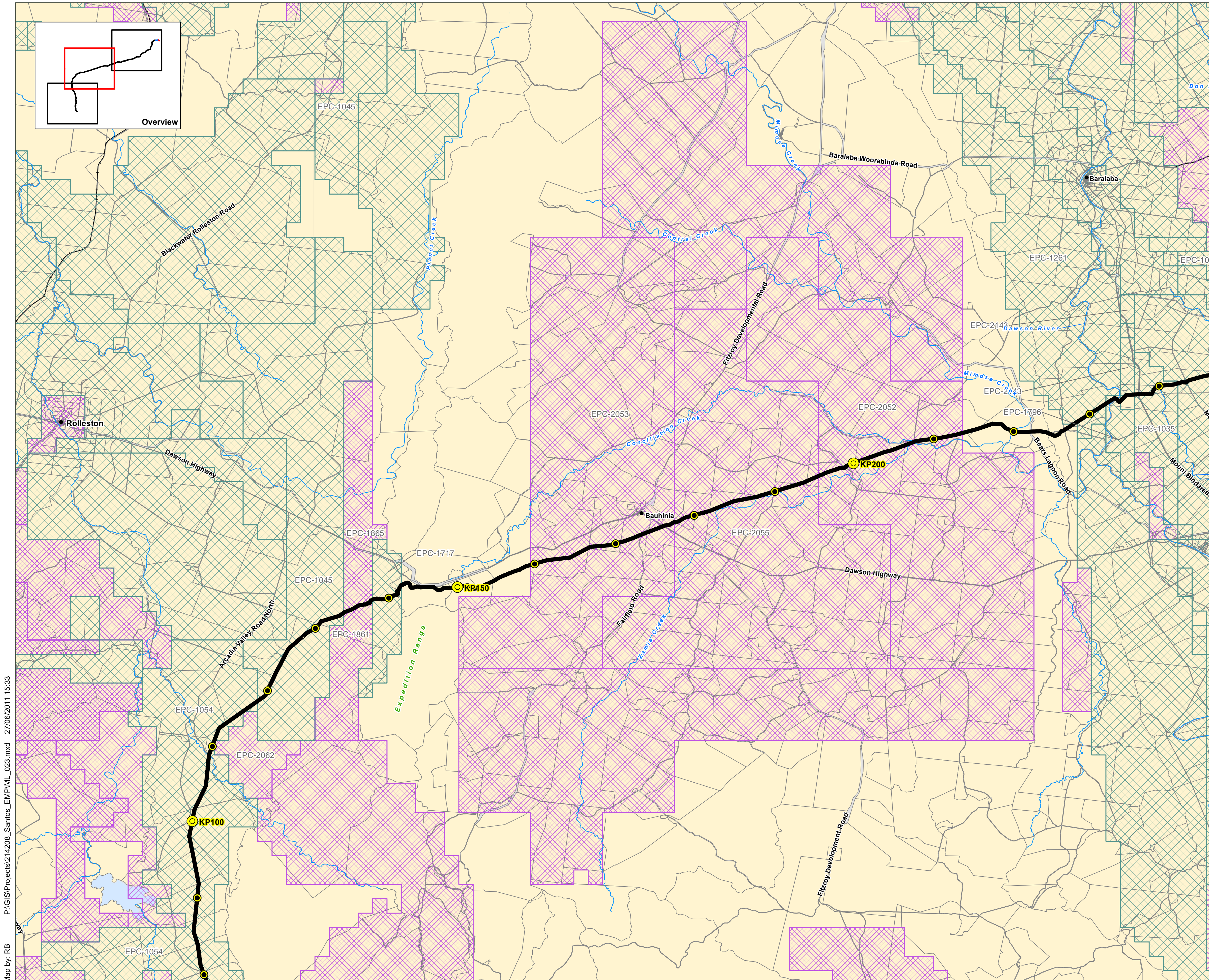
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- Exploration Permit for Coal Status
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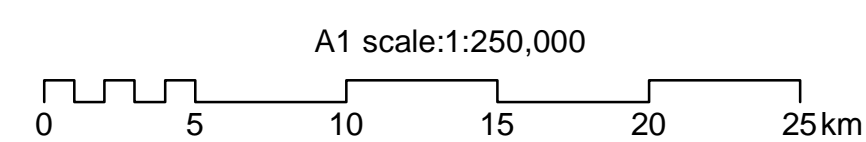
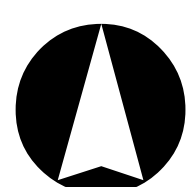
Mining Tenure- Exploration Permit (Coal) Figure 8.3c (Page 2 of 3)

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Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

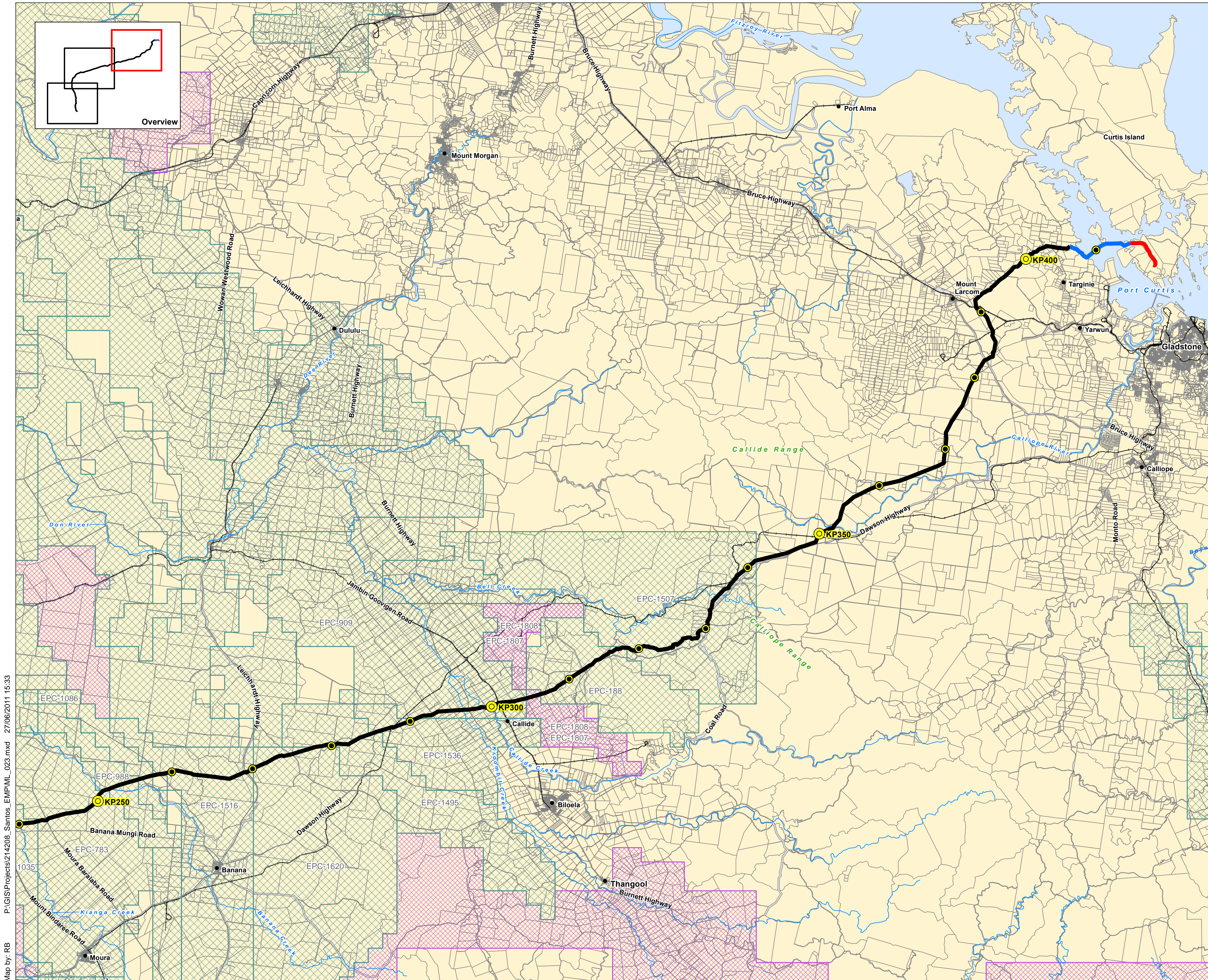
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- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

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- 10km

Exploration Permit for Coal Status

- Granted
- Application
- Cadastre
- Rail
- Watercourse
- Major Road



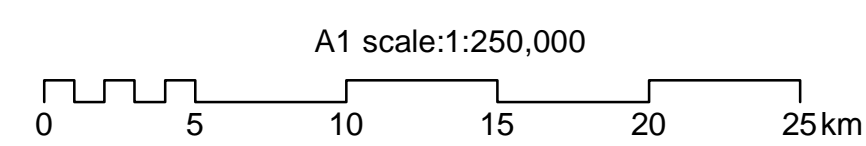
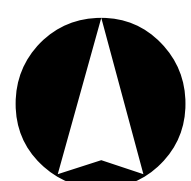
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Mining Tenure- Exploration Permit (Coal) Figure 8.3c (Page 3 of 3)

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 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

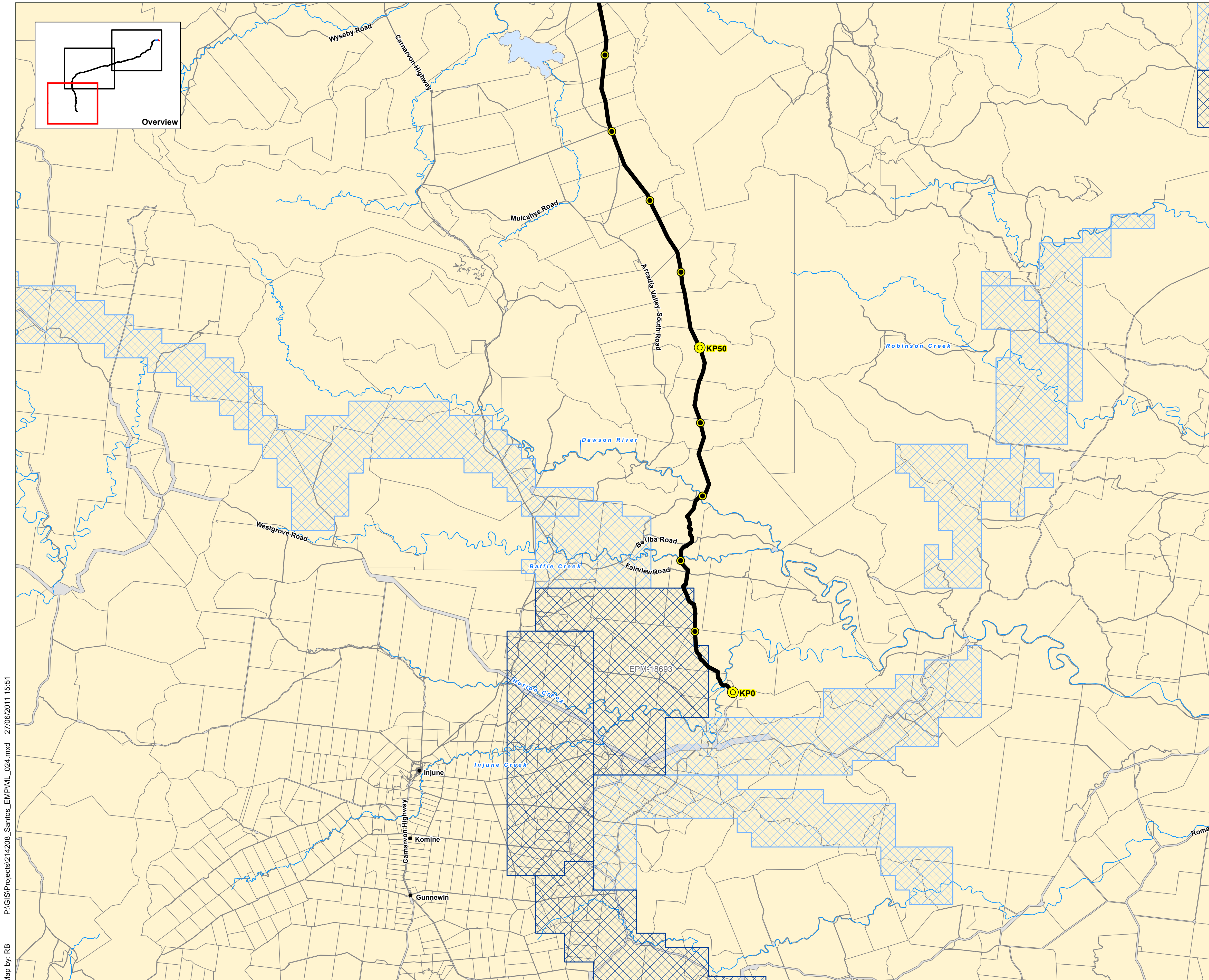
- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 50km
- 10km

Exploration Permit for Minerals Status

- Granted
- Application
- Cadastre
- Rail
- Watercourse
- Major Road



Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Cadastre: Department of Environment and Resource Management, Jun 2011.
 Resource Tenure: Department of Mines and Energy, Feb 2011.

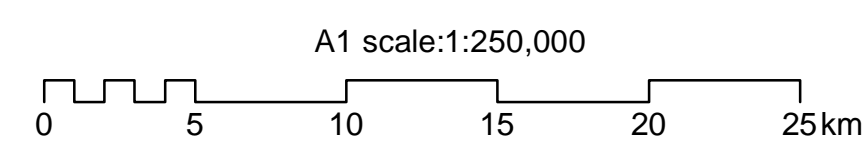
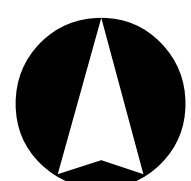
Mining Tenure- Exploration Permit (Minerals) Figure 8.3d (Page 1 of 3)

Date: 27/06/2011

Version: c

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Map by: RB

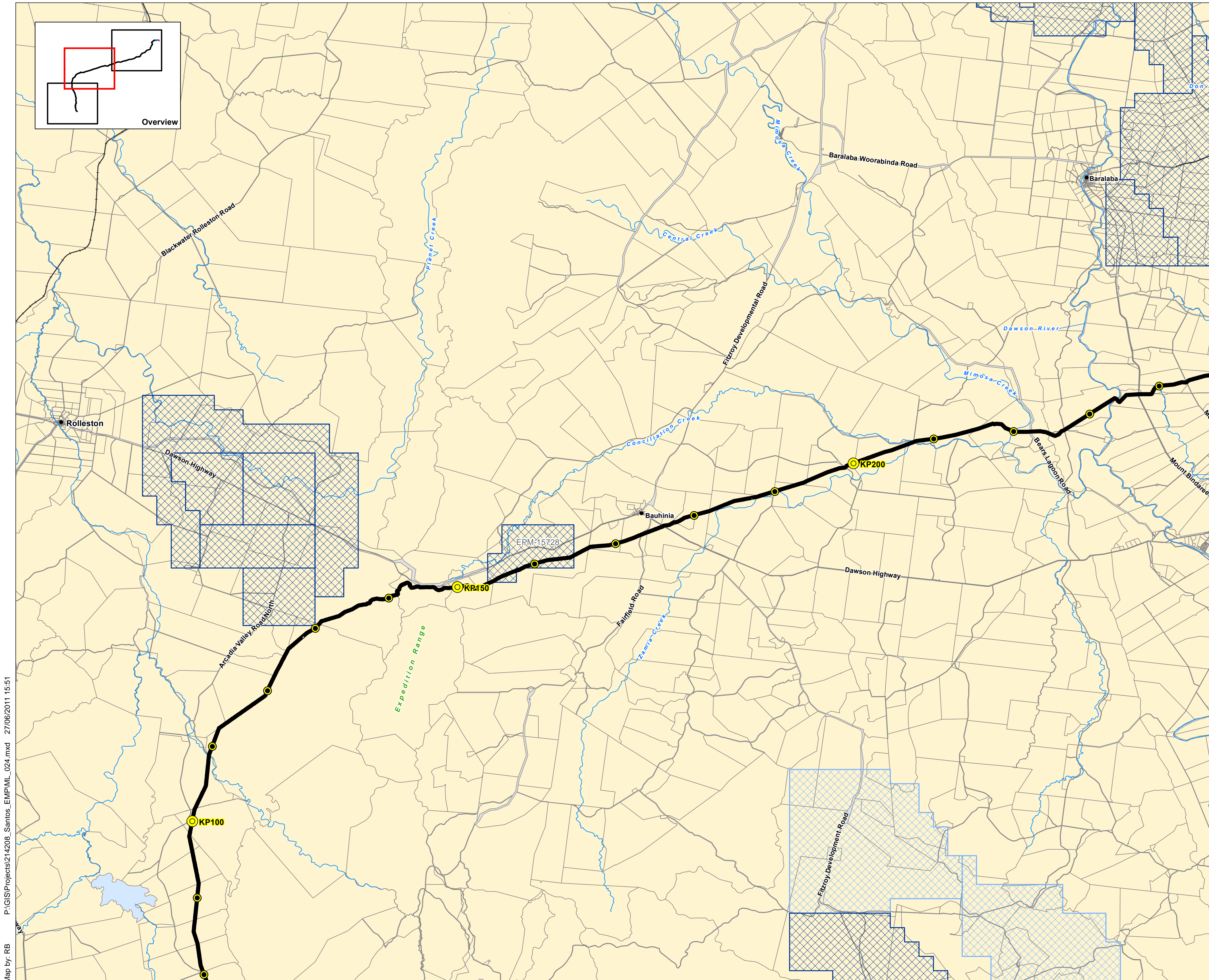


GLNG No: 3381-40-0418
 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

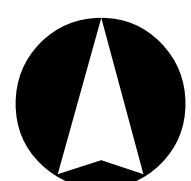
- Gas Transmission Pipeline (GTP)
 - Mainland GTP EM Plan
 - Marine Crossing GTP EM Plan
 - Curtis Island GTP EM Plan
- Kilometre Post Distance Marker
 - 50km
 - 10km
- Exploration Permit for Minerals Status
 - Granted
 - Application
 - Cadastre
 - Rail
 - Watercourse
 - Major Road



Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Cadastre: Department of Environment and Resource Management, Jun 2011.
 Resource Tenure: Department of Mines and Energy, Feb 2011.

**Mining Tenure-
 Exploration Permit (Minerals)
 Figure 8.3d (Page 2 of 3)**

Map by: RB P:\GIS\Projects\214208_Santos_EMP\ML_024.mxd 27/06/2011 15:51



A1 scale:1:250,000
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GLNG No: 3381-40-0418
 Coordinate system: GCS GDA 1994

Date: 27/06/2011

Version: c



Mainland GTP EM Plan

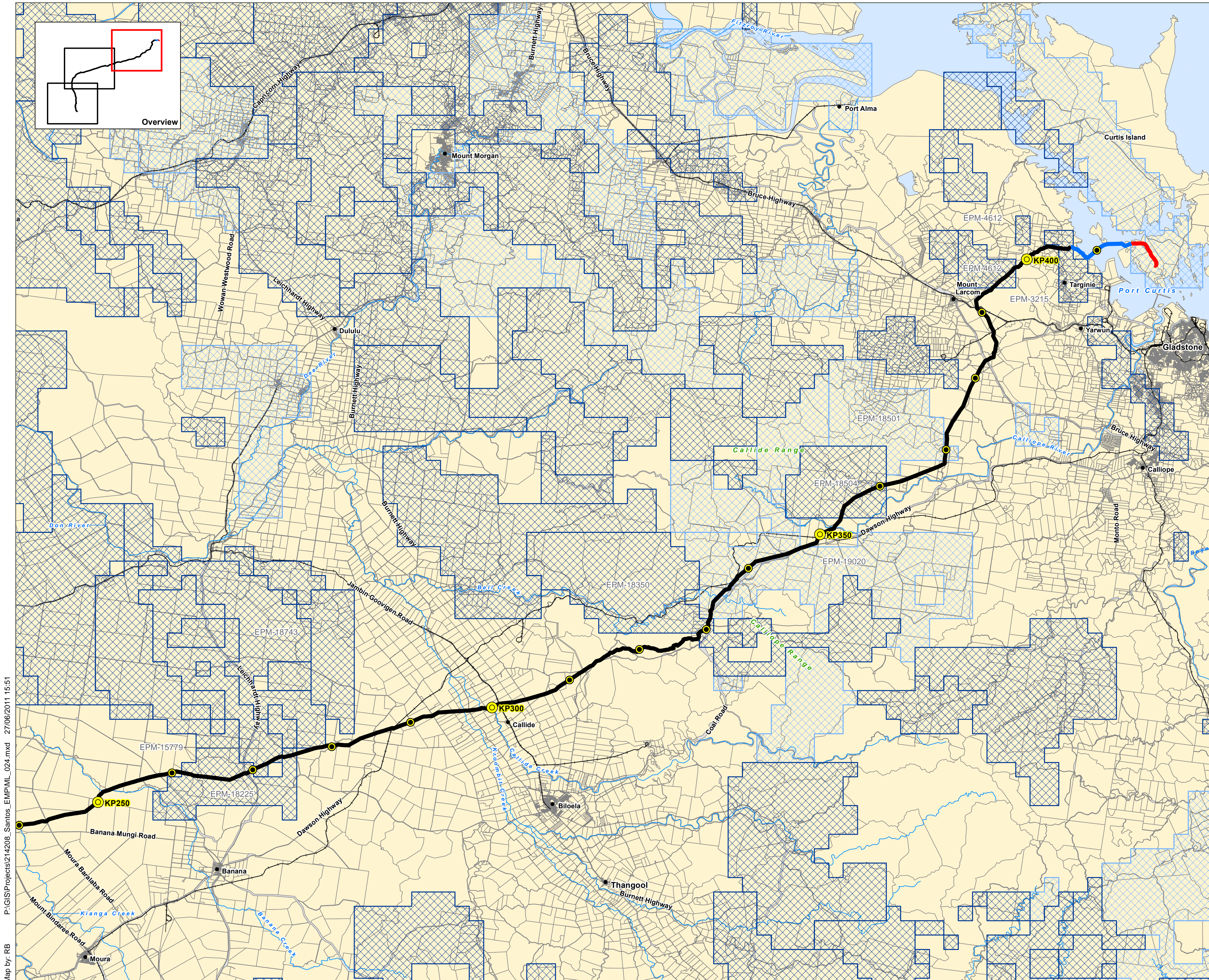
- Gas Transmission Pipeline (GTP)
 - Mainland GTP EM Plan
 - Marine Crossing GTP EM Plan
 - Curtis Island GTP EM Plan
- Kilometre Post Distance Marker
 - 50km
 - 10km
- Exploration Permit for Minerals Status
 - Granted
 - Application
 - Cadastre
- Rail
- Watercourse
- Major Road

Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Cadastre: Department of Environment and Resource Management, Jun 2011.
 Resource Tenure: Department of Mines and Energy, Feb 2011.

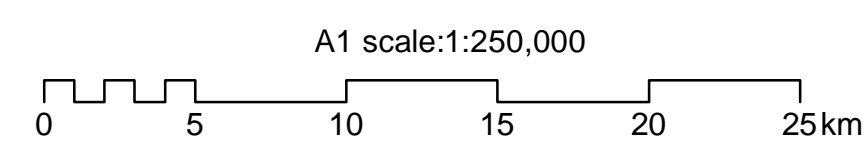
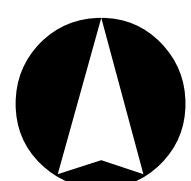
Mining Tenure- Exploration Permit (Minerals) Figure 8.3d (Page 3 of 3)

Date: 27/06/2011

Version: c



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 Map by: RB



GLNG No: 3381-40-0418
 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

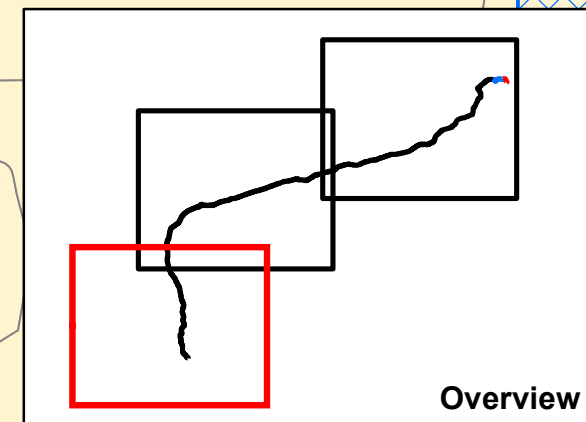
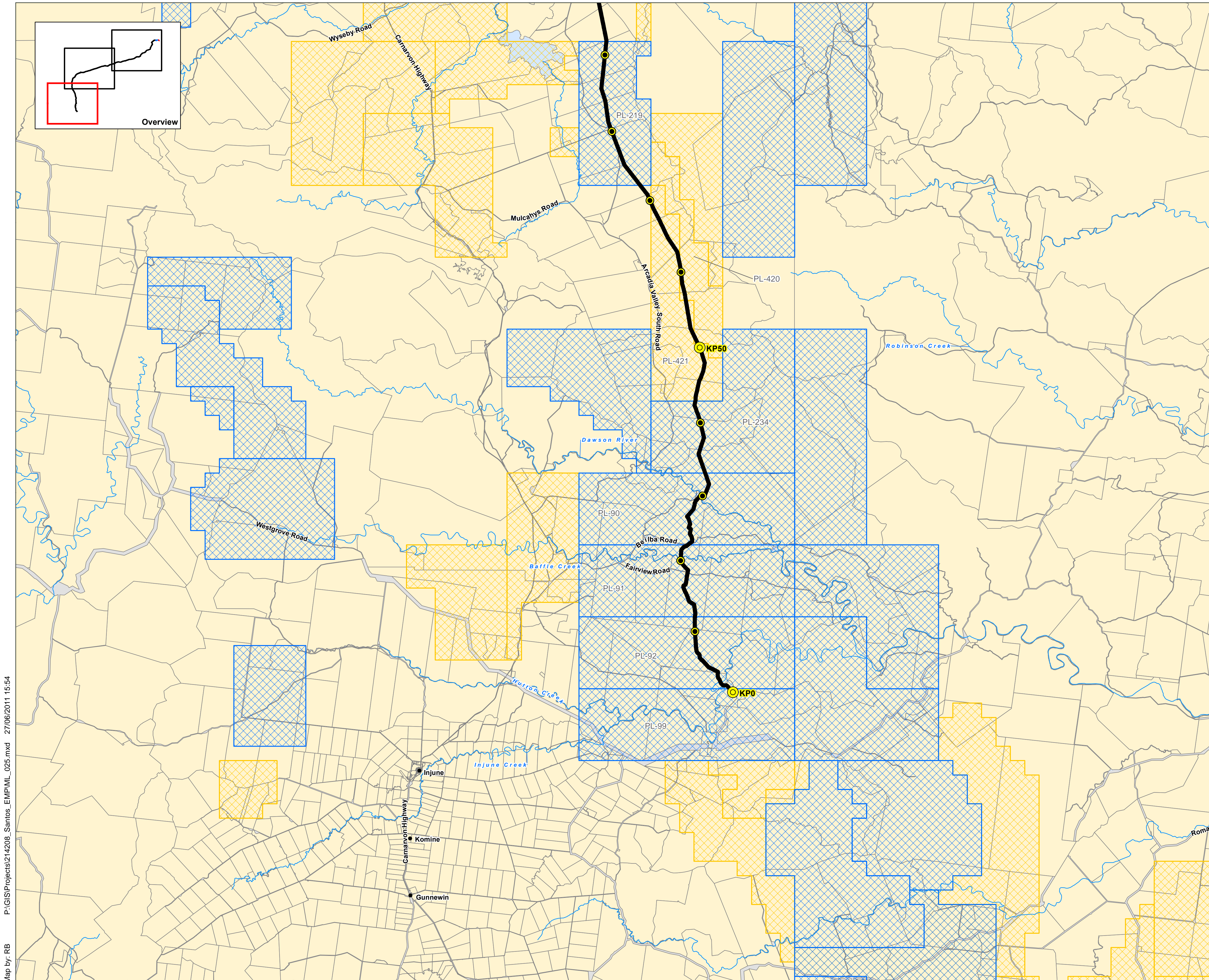
- Gas Transmission Pipeline (GTP)
 - Mainland GTP EM Plan
 - Marine Crossing GTP EM Plan
 - Curtis Island GTP EM Plan
- Kilometre Post Distance Marker
 - 50km
 - 10km
- Petroleum Tenure Status
 - Granted
 - Application
 - Cadastre
 - Rail
 - Watercourse
 - Major Road

Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Cadastre: Department of Environment and Resource Management, Jun 2011.
 Resource Tenure: Department of Mines and Energy, Feb 2011.

Petroleum Tenures
Figure 8.3e (Page 1 of 3)

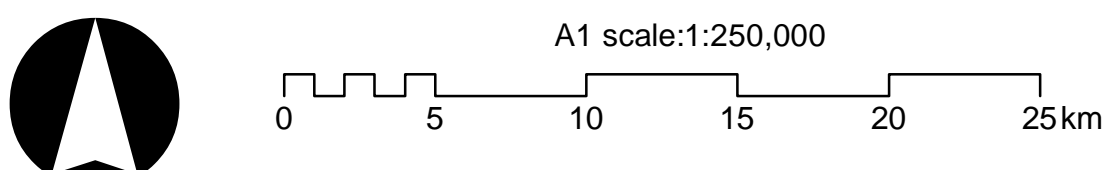
Date: 27/06/2011

Version: c



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Map by: RB



GLNG No: 3381-40-0419
 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

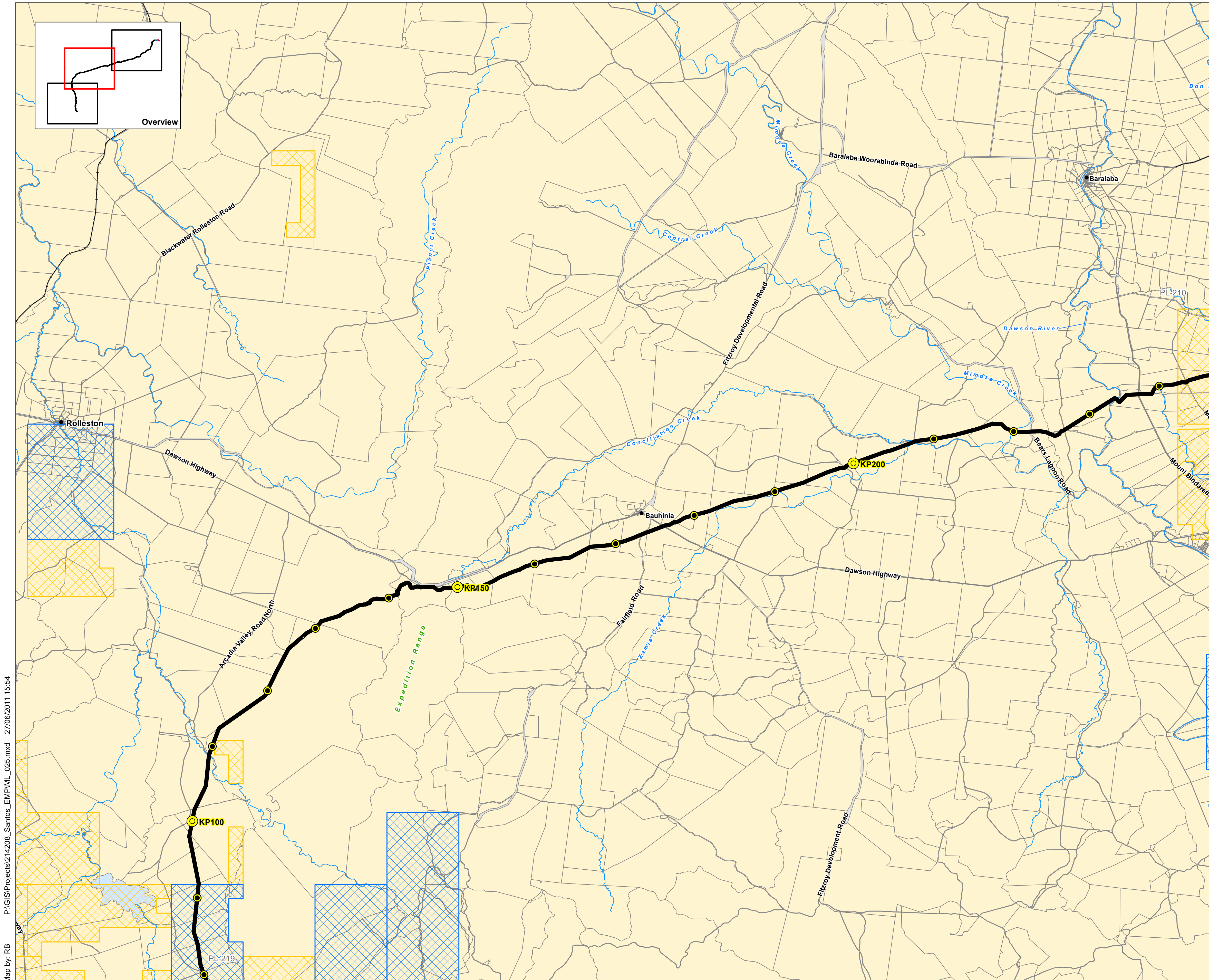
- Gas Transmission Pipeline (GTP)
- Mainland GTP EM Plan
 - Marine Crossing GTP EM Plan
 - Curtis Island GTP EM Plan
- Kilometre Post Distance Marker
- 50km
 - 10km
- Petroleum Tenure Status
- Granted
 - Application
 - Cadastre
 - Rail
 - Watercourse
 - Major Road

Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Cadastre: Department of Environment and Resource Management, Jun 2011.
 Resource Tenure: Department of Mines and Energy, Feb 2011.

Petroleum Tenures
Figure 8.3e (Page 2 of 3)

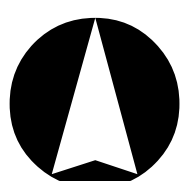
Date: 27/06/2011

Version: c



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Map by: RB



A1 scale: 1:250,000
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GLNG No: 3381-40-0419
 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 50km
- 10km

Petroleum Tenure Status

- Granted
- Application
- Cadastre
- Rail
- Watercourse
- Major Road

Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Cadastre: Department of Environment and Resource Management, Jun 2011.
 Resource Tenure: Department of Mines and Energy, Feb 2011.

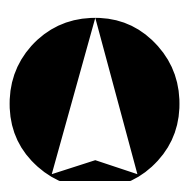
Petroleum Tenures Figure 8.3e (Page 3 of 3)

Date: 27/06/2011

Version: c



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 Map by: RB



A1 scale: 1:250,000
 0 5 10 15 20 25km

GLNG No: 3381-40-0419
 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 50km
- 10km

Queensland Land Use Mapping Program (2004)

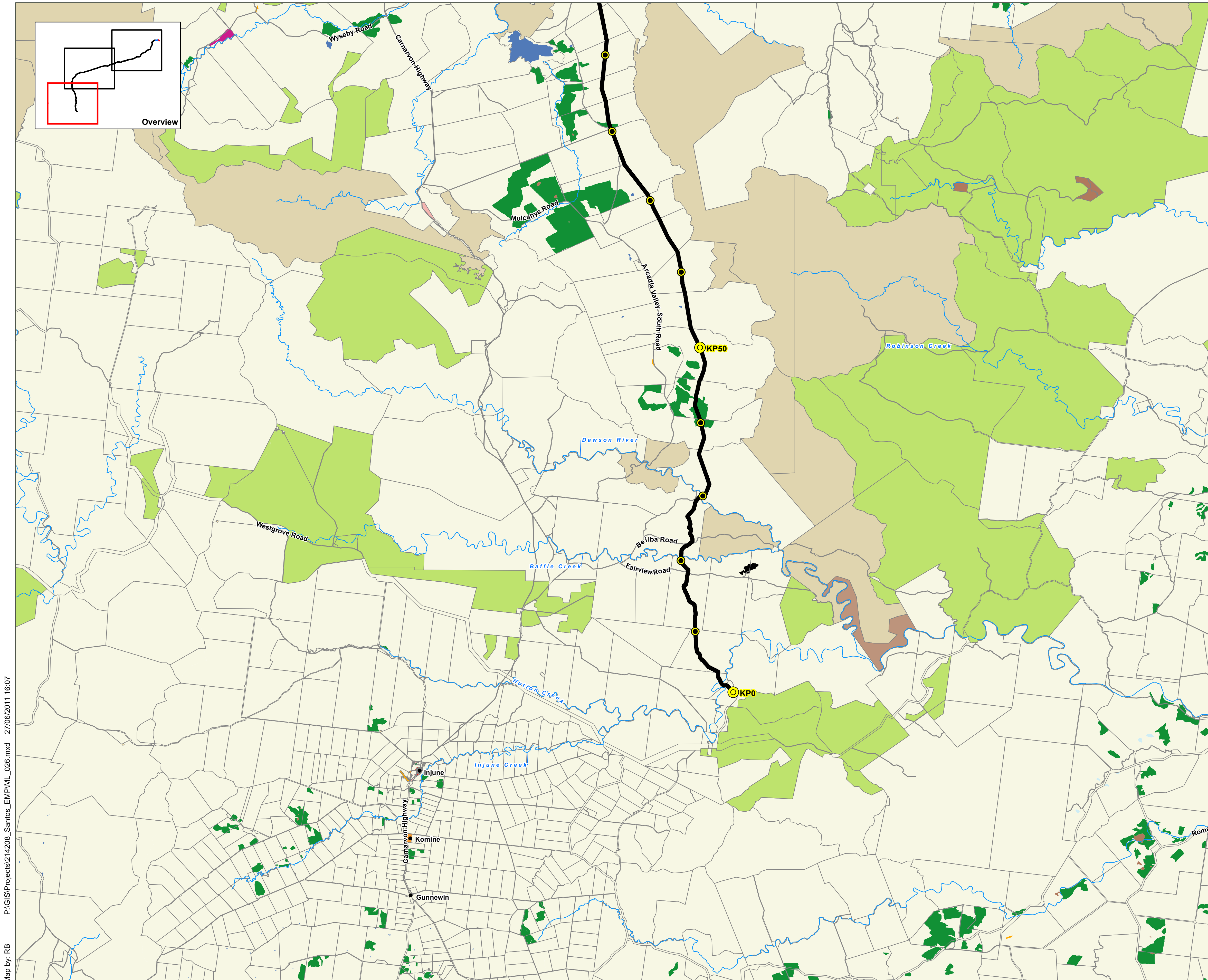
- Nature conservation
- Managed resource protection
- Other minimal use
- Grazing natural vegetation
- Production forestry
- Plantation forestry
- Cropping
- Irrigated cropping
- Irrigated perennial horticulture
- Intensive horticulture
- Intensive animal production
- Manufacturing and industrial
- Residential
- Services
- Utilities
- Transport and communication
- Mining
- Waste treatment and disposal
- Lake
- Reservoir/dam
- River
- Marsh/wetland
- Cadastre
- Rail
- Watercourse
- Major Road

Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Cadastre: Department of Environment and Resource Management, Jun 2011.
 Queensland Land Use Mapping Program: Queensland Land Use Mapping Program 1999 with updates from 2004.
 Queensland Government, 1999, 2004.
 Temporary Workers Accommodation Camps: GLNG Pipeline FEED Logistics Study, GHD

Land Use Figure 8.4 (Page 1 of 3)

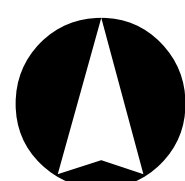
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Map by: RB



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GLNG No: 3381-40-0420
Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 50km
- 10km

Queensland Land Use Mapping Program (2004)

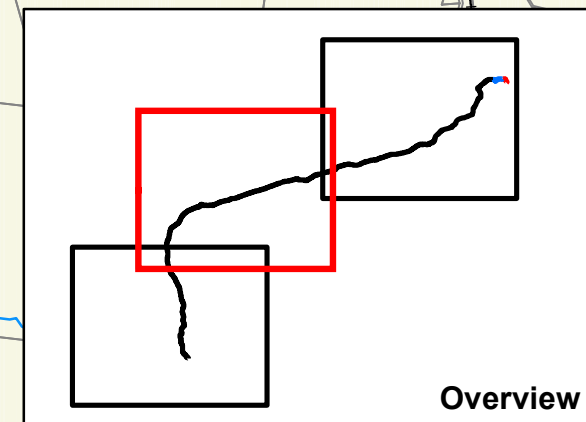
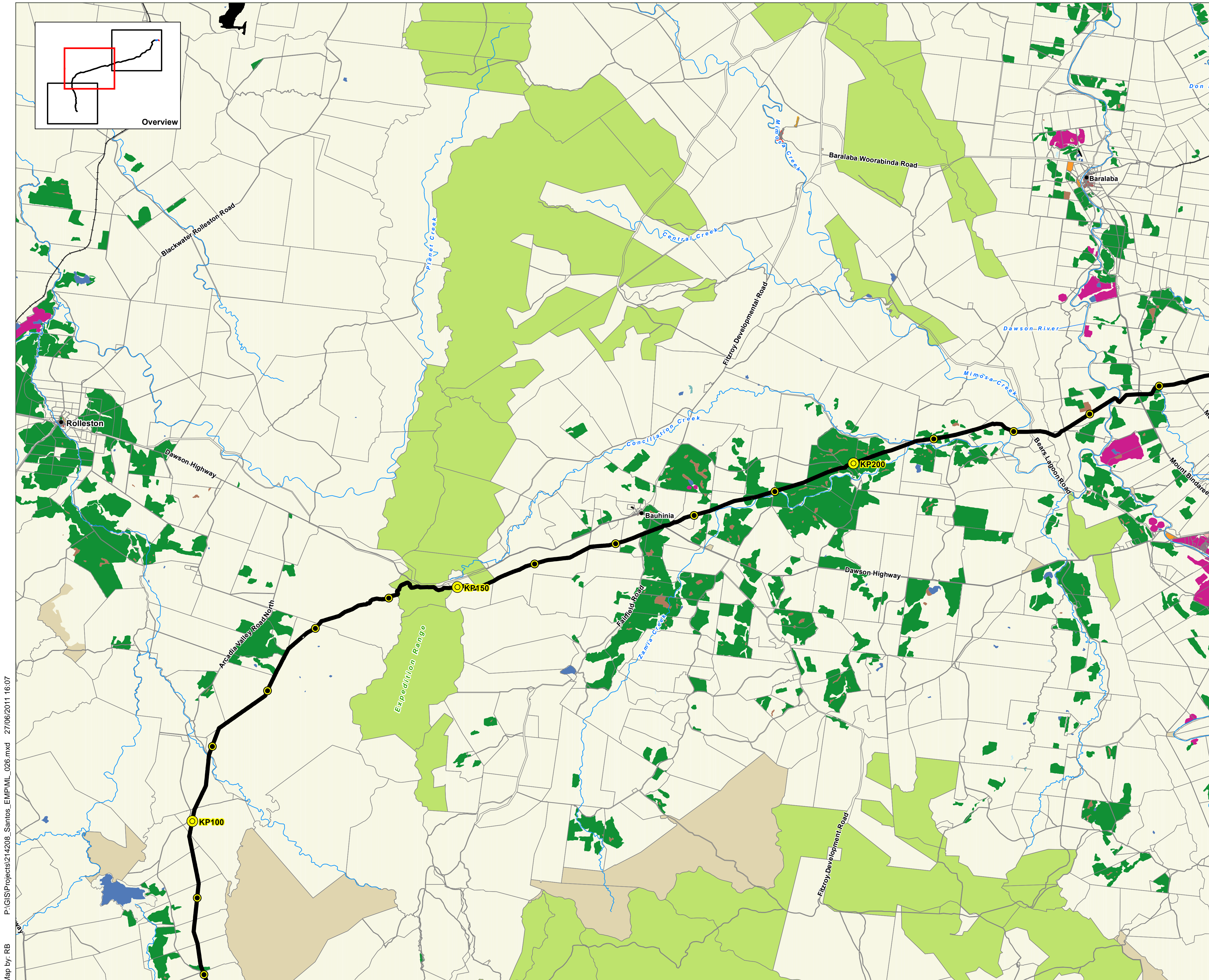
- Nature conservation
- Managed resource protection
- Other minimal use
- Grazing natural vegetation
- Production forestry
- Plantation forestry
- Cropping
- Irrigated cropping
- Irrigated perennial horticulture
- Intensive horticulture
- Intensive animal production
- Manufacturing and industrial
- Residential
- Services
- Utilities
- Transport and communication
- Mining
- Waste treatment and disposal
- Lake
- Reservoir/dam
- River
- Marsh/wetland
- Cadastre
- Rail
- Watercourse
- Major Road

Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Cadastre: Department of Environment and Resource Management, Jun 2011.
 Queensland Land Use Mapping Program: Queensland Land Use Mapping Program 1999 with updates from 2004.
 Queensland Government, 1999, 2004.
 Temporary Workers Accommodation Camps: GLNG Pipeline FEED Logistics Study, GHD

Land Use Figure 8.4 (Page 2 of 3)

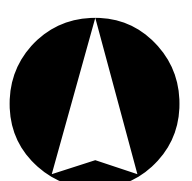
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Map by: RB



A1 scale: 1:250,000
 0 5 10 15 20 25km

GLNG No: 3381-40-0420
 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 50km
- 10km

Queensland Land Use Mapping Program (2004)

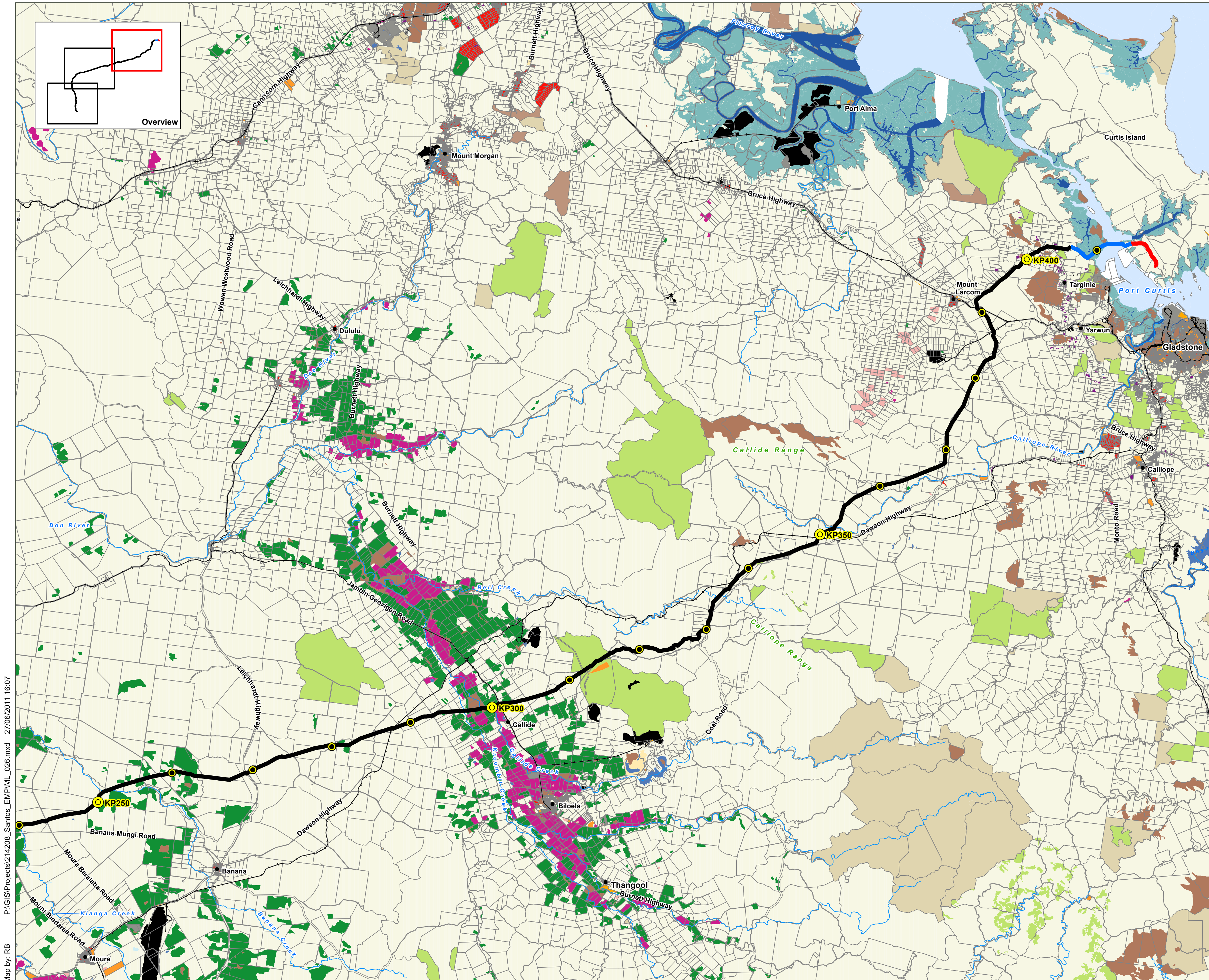
- Nature conservation
- Managed resource protection
- Other minimal use
- Grazing natural vegetation
- Production forestry
- Plantation forestry
- Cropping
- Irrigated cropping
- Irrigated perennial horticulture
- Intensive horticulture
- Intensive animal production
- Manufacturing and industrial
- Residential
- Services
- Utilities
- Transport and communication
- Mining
- Waste treatment and disposal
- Lake
- Reservoir/dam
- River
- Marsh/wetland
- Cadastre
- Rail
- Watercourse
- Major Road

Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Cadastre: Department of Environment and Resource Management, Jun 2011.
 Queensland Land Use Mapping Program: Queensland Land Use Mapping Program 1999 with updates from 2004. Queensland Government, 1999, 2004.
 Temporary Workers Accommodation Camps: GLNG Pipeline FEED Logistics Study, GHD

Land Use Figure 8.4 (Page 3 of 3)

Date: 27/06/2011

Version: c



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Map by: RB

GLNG No: 3381-40-0420
 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

- Gas Transmission Pipeline (GTP)
 - Mainland GTP EM Plan
 - Marine Crossing GTP EM Plan
 - Curtis Island GTP EM Plan

- Kilometre Post Distance Marker
 - 50km
 - 10km
- World Heritage Area

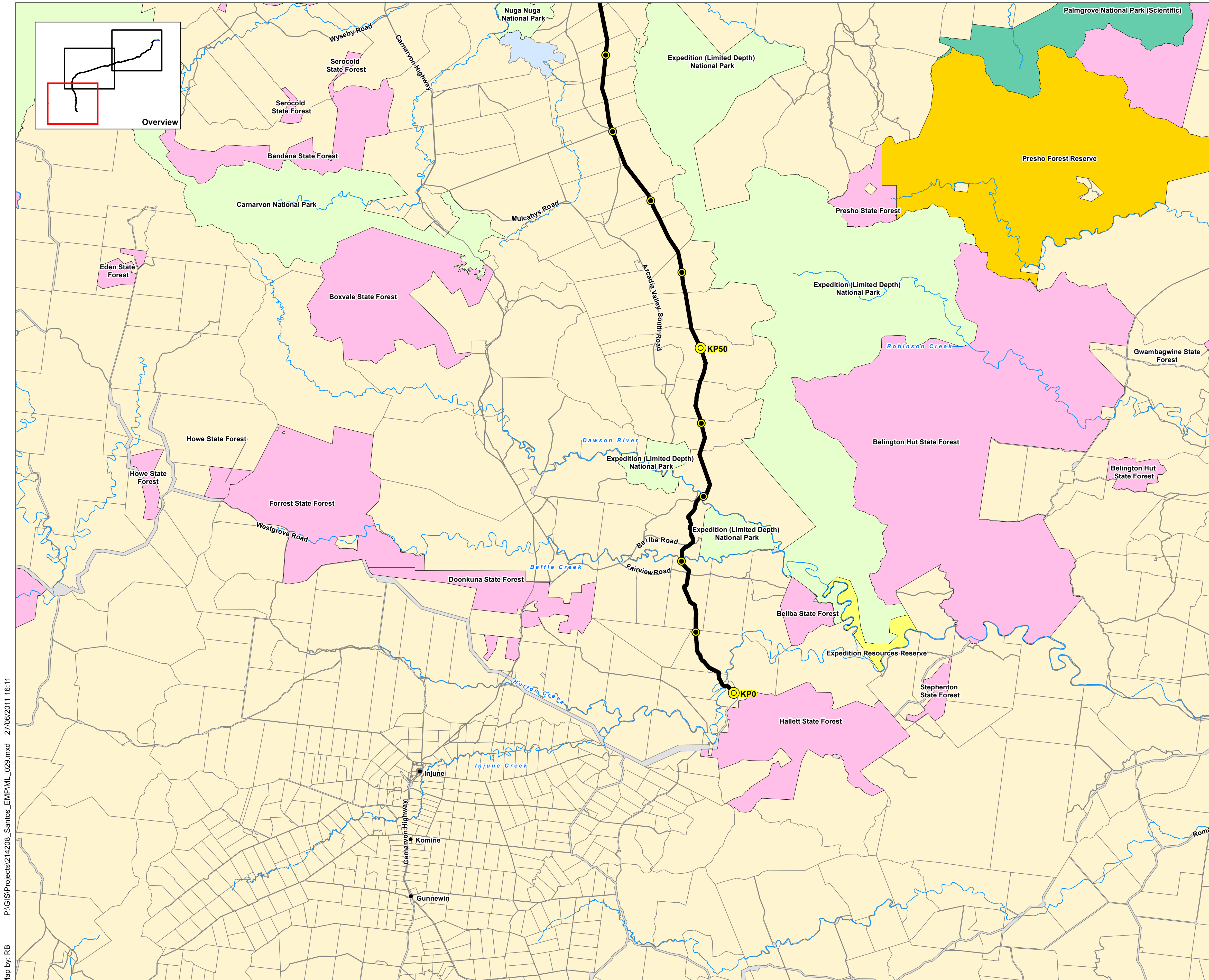
- Protected Area
 - National Park (scientific)
 - National Park
 - National Park (recovery)
 - Conservation Park
 - Resource Reserve
 - Forest Reserve
 - State Forest
 - Timber Reserve
 - Cadastre
- Rail
- Watercourse
- Major Road

Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Cadastre: Department of Environment and Resource Management, Jun 2011.
 Protected Areas: Department of Environment and Resource Management, Feb 2011.
 World Heritage Area: Department of Environment and Resource Management, Feb 2011.

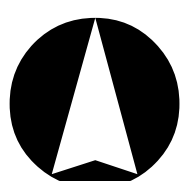
Conservation Areas: World Heritage Area and Protected Areas Figure 8.5 (Page 1 of 3)

Date: 27/06/2011

Version: c



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Map by: RB



GLNG No: 3381-40-0421
 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

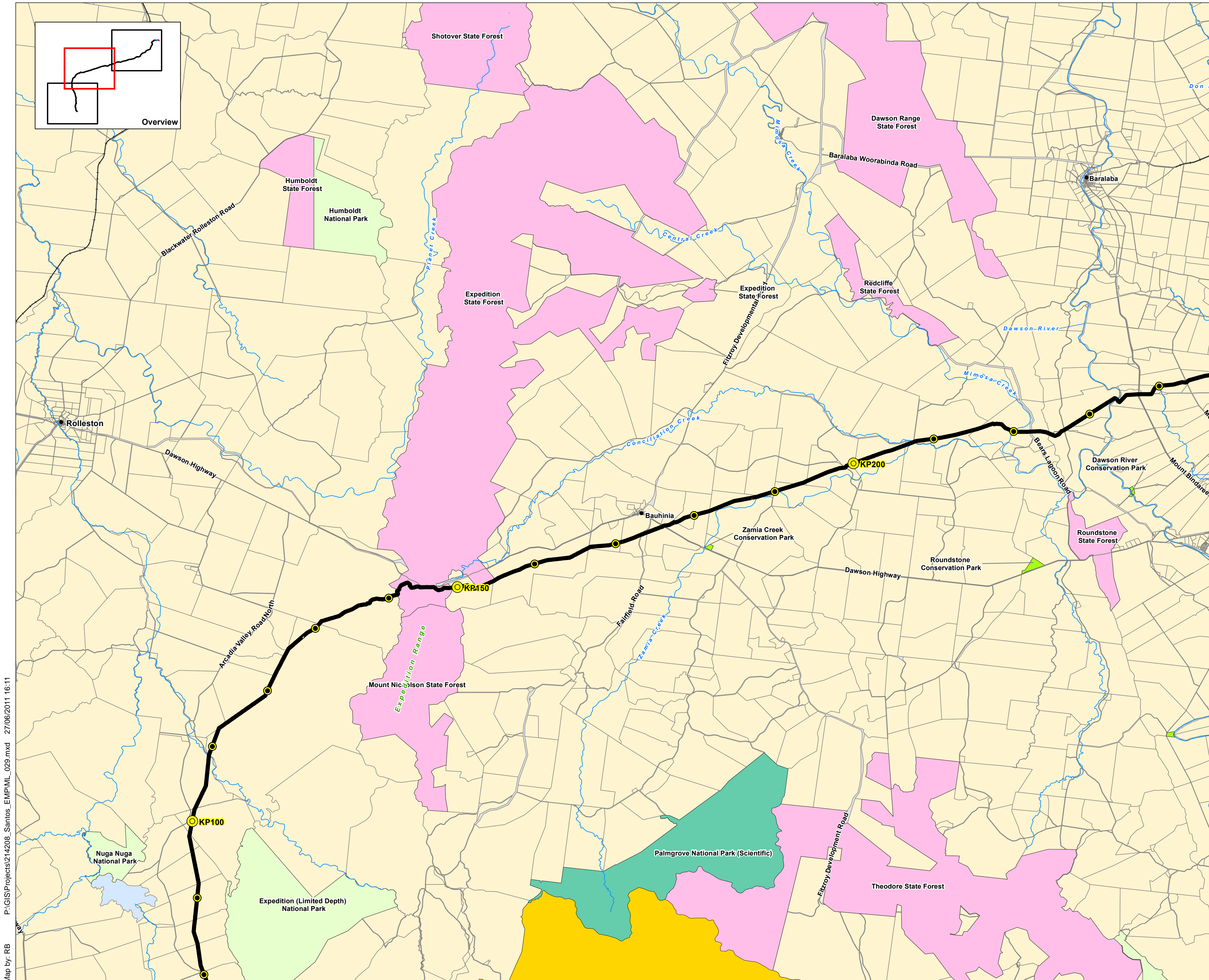
- Gas Transmission Pipeline (GTP)
 - Mainland GTP EM Plan
 - Marine Crossing GTP EM Plan
 - Curtis Island GTP EM Plan
- Kilometre Post Distance Marker
 - 50km
 - 10km
- World Heritage Area
- Protected Area
 - National Park (scientific)
 - National Park
 - National Park (recovery)
 - Conservation Park
 - Resource Reserve
 - Forest Reserve
 - State Forest
 - Timber Reserve
 - Cadastre
- Rail
- Watercourse
- Major Road

Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Cadastre: Department of Environment and Resource Management, Jun 2011.
 Protected Areas: Department of Environment and Resource Management, Feb 2011.
 World Heritage Area: Department of Environment and Resource Management, Feb 2011.

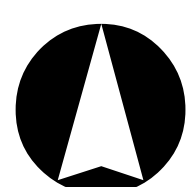
Conservation Areas: World Heritage Area and Protected Areas Figure 8.5 (Page 2 of 3)

Date: 27/06/2011

Version: c



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Map by: RB



A1 scale:1:250,000
0 5 10 15 20 25km

GLNG No: 3381-40-0421
Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 50km
- 10km

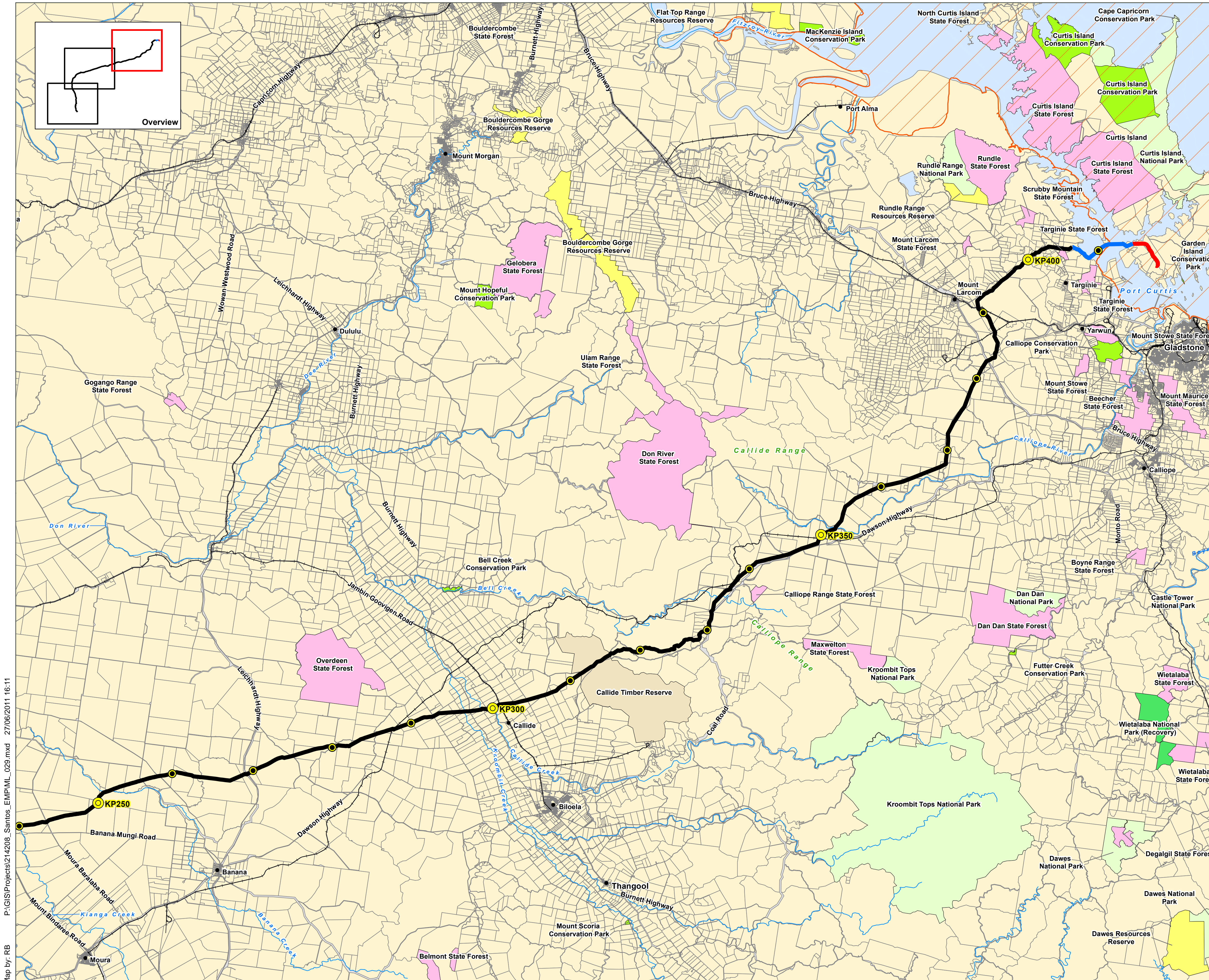
World Heritage Area

Protected Area

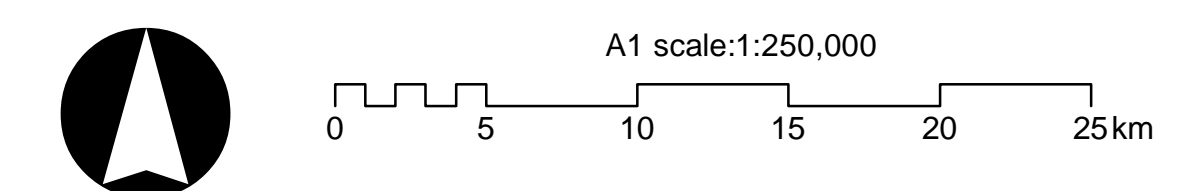
- National Park (scientific)
- National Park
- National Park (recovery)
- Conservation Park
- Resource Reserve
- Forest Reserve
- State Forest
- Timber Reserve
- Cadastre
- Rail
- Watercourse
- Major Road

Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Cadastre: Department of Environment and Resource Management, Jun 2011.
 Protected Areas: Department of Environment and Resource Management, Feb 2011.
 World Heritage Area: Department of Environment and Resource Management, Feb 2011.

**Conservation Areas:
 World Heritage Area
 and Protected Areas
 Figure 8.5 (Page 3 of 3)**



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 Map by: RB



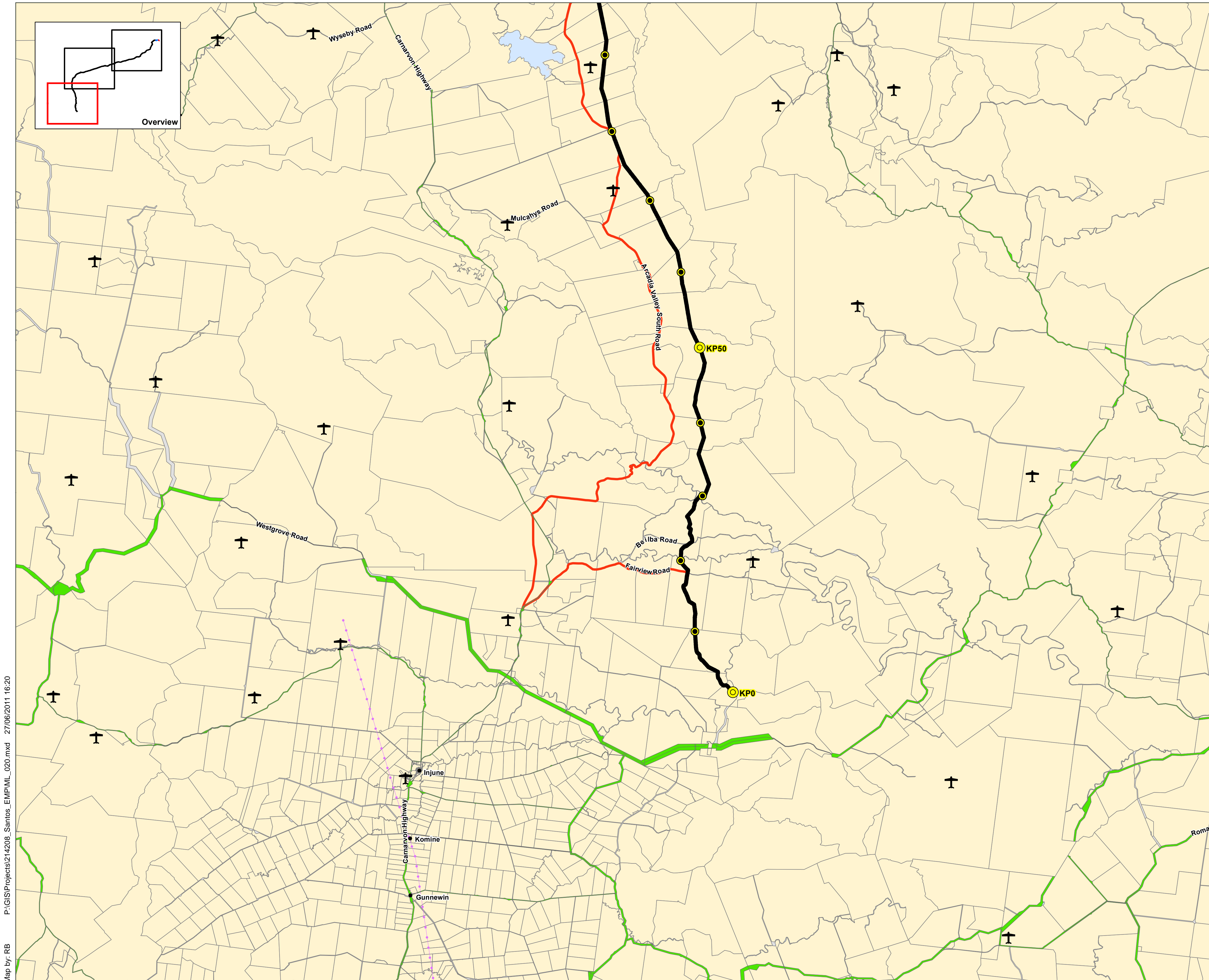
GLNG No: 3381-40-0421
 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

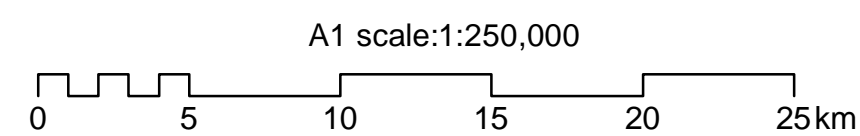
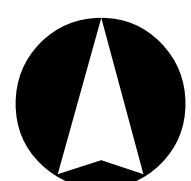
- Gas Transmission Pipeline (GTP)
 - Mainland GTP EM Plan
 - Marine Crossing GTP EM Plan
 - Curtis Island GTP EM Plan
- Kilometre Post Distance Marker
 - 50km
 - 10km
- Airport
- Landing Ground
- Heliport
- Powerlines
- Stock Route
- Haulage Route
- Cadastre
- Rail
- Major Road

Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Cadastre: Department of Environment and Resource Management, Jun 2011.
 Resource Tenure: Department of Mines and Energy, Feb 2011.
 Haulage Route: GLNG, Feb 2011
 Stock Route: Department of Environment and Resource Management, Feb 2011.



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Map by: RB



A1 scale:1:250,000

GLNG No: 3381-40-0422
 Coordinate system: GCS GDA 1994

Existing Infrastructure and Services
Figure 8.6 (Page 1 of 3)

Date: 27/06/2011

Version: c



Mainland GTP EM Plan

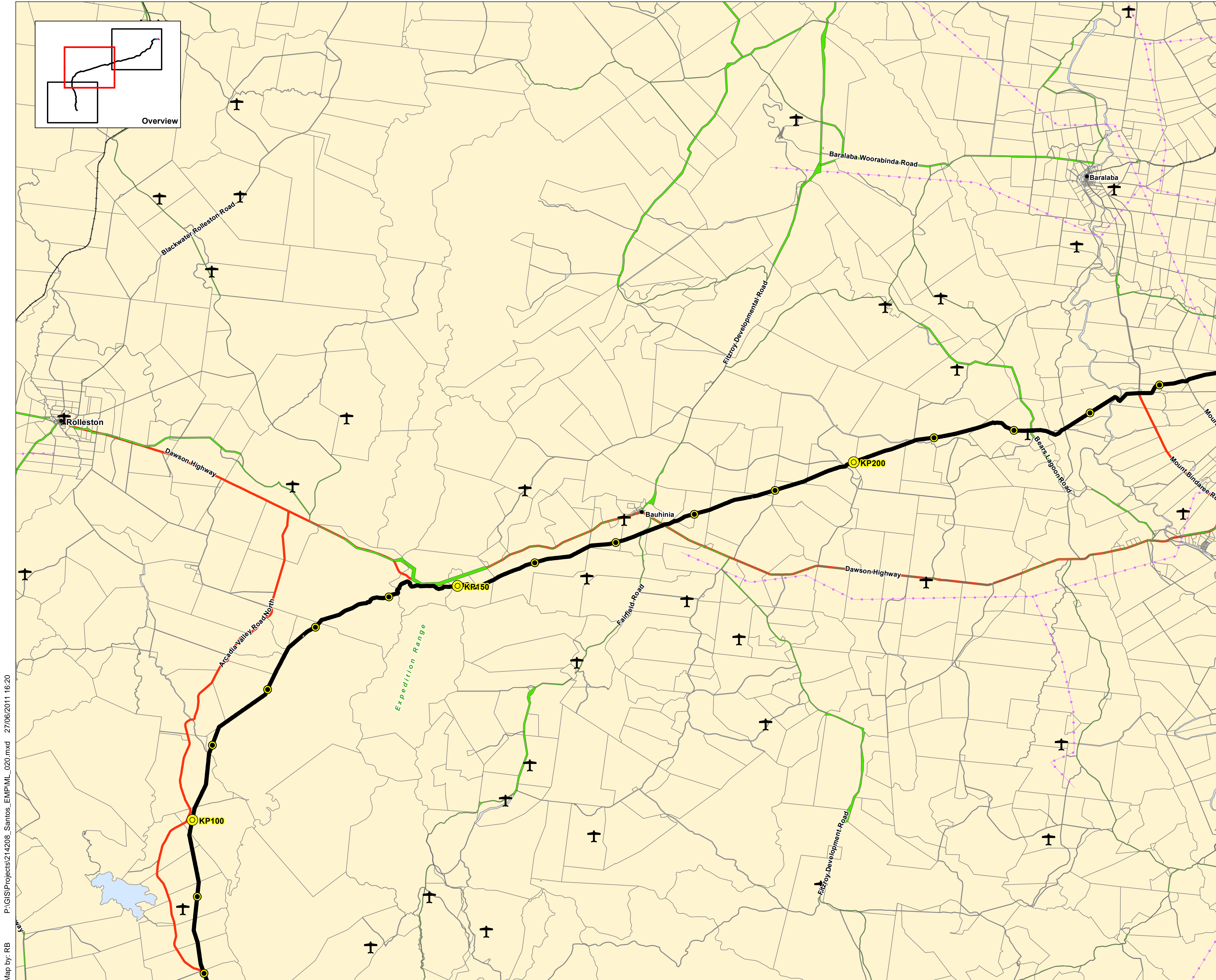
- Gas Transmission Pipeline (GTP)
 - Mainland GTP EM Plan
 - Marine Crossing GTP EM Plan
 - Curtis Island GTP EM Plan
- Kilometre Post Distance Marker
 - 50km
 - 10km
- Airport
- Landing Ground
- Helipoint
- Powerlines
- Stock Route
- Haulage Route
- Cadastre
- Rail
- Major Road

Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Cadastre: Department of Environment and Resource Management, Jun 2011.
 Resource Tenure: Department of Mines and Energy, Feb 2011.
 Haulage Route: GLNG, Feb 2011
 Stock Route: Department of Environment and Resource Management, Feb 2011.

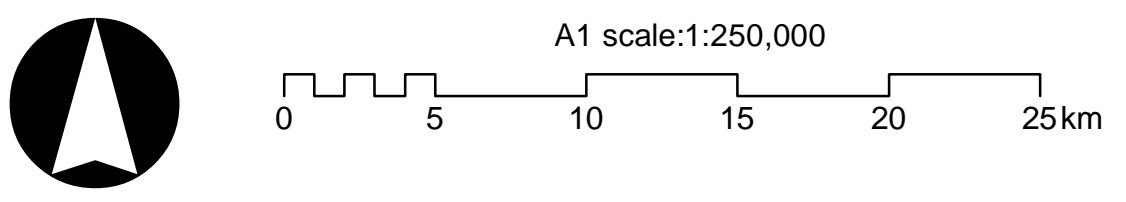
Existing Infrastructure and Services Figure 8.6 (Page 2 of 3)

Date: 27/06/2011

Version: c



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Map by: RB



GLNG No: 3381-40-0422
 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

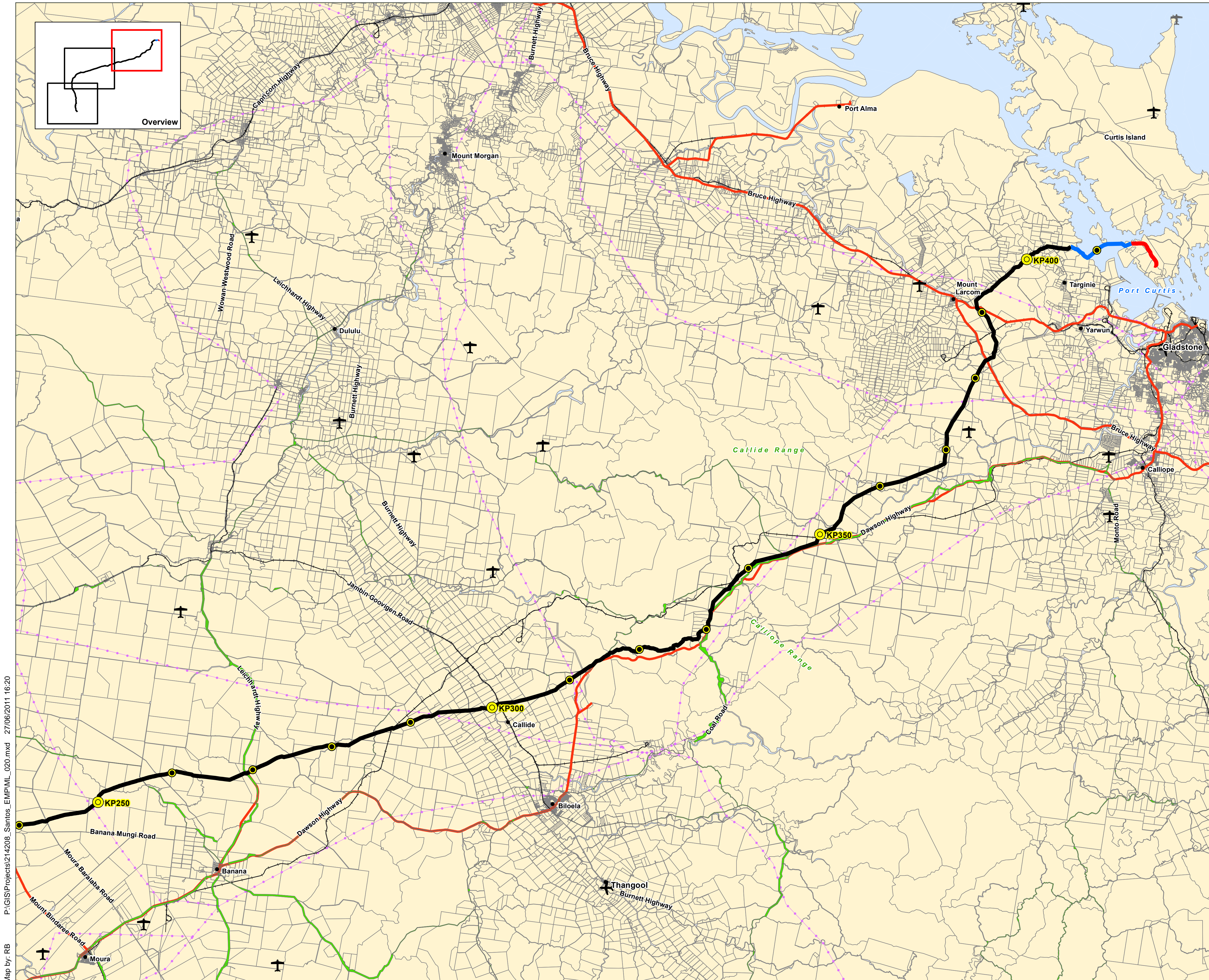
Kilometre Post Distance Marker

- 50km
- 10km

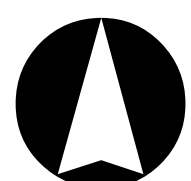
- Airport
- Landing Ground
- Helipoint

- Powerlines
- Stock Route
- Haulage Route
- Cadastre
- Rail
- Major Road

Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Cadastre: Department of Environment and Resource Management, Jun 2011.
 Resource Tenure: Department of Mines and Energy, Feb 2011.
 Haulage Route: GLNG, Feb 2011
 Stock Route: Department of Environment and Resource Management, Feb 2011.



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 Map by: RB



A1 scale: 1:250,000
 0 5 10 15 20 25km

GLNG No: 3381-40-0422
 Coordinate system: GCS GDA 1994

Existing Infrastructure and Services
 Figure 8.6 (Page 3 of 3)

Date: 27/06/2011

Version: c

8.3 Potential adverse or beneficial impacts on existing land tenure and land use

8.3.1 Landholders and land use

The Mainland GTP RoW is to be strategically placed to avoid interference and adverse impacts on existing land uses where practical. In addition, all proponents GTP's through the GSDA (23 km) and CICSDA (45 km) follow a similar route to consolidate the impacts on these areas as specified in their respective Development Schemes.

The land directly affected by the Mainland GTP RoW is predominantly freehold land with a large number of private landholders. The process of liaising with each landholder and entering into Land Management Agreements has been completed. This includes discussion and negotiation with private landholders with regards to adverse and beneficial impacts on land use and the appropriate means to mitigate impacts where necessary.

The main potential impact of the Mainland GTP RoW on agricultural land uses will occur during construction when agricultural and grazing activities will be temporarily restricted, particularly within the 30 to 40 m wide RoW. Land use can generally recommence following construction, with landholders retaining full access and use of the surface area above the GTP. This is typically subject to some minor restrictions to preclude activities that would threaten GTP integrity or significantly impede future access to the GTP (eg construction above the pipeline, planting trees and some crops in close proximity to the GTP, or installation of subsurface infrastructure).

As GTP construction will advance at an average rate of approximately 1.5 km per day, the period that any one location is affected by the peak of construction activities will be limited to a few weeks. The exception will be at the temporary pipe storage sites and washdown areas that will be located within the RoW, and also the construction camps, which are proposed to be located at the following locations:

- Camp 1 – Bundaleer – KP 75
- Camp 2 – Bauhinia – KP 180
- Camp 3 – Banana – KP 275
- Camp 4 – Calliope KP – 355

These construction camps will be sized to accommodate approximately 450 persons at main camps and 200 persons at behind and advanced camps. An area of approximately 8 ha will be required per camp. Each camp will be operational while construction is occurring within that area, with the size of the camp then decreasing as construction activities in that particular section are completed. The camps, comprised primarily of pre-fabricated modular buildings, will then be transported to the next location and installed to accommodate construction personnel shifting from one section to the next. As camps are not permanent features and as each site will be rehabilitated as per the LRMP (refer Appendix G) and Chapter 15 of this EM plan, potential impacts on land tenure and use are considered to be minimal.

The trench for the Mainland GTP RoW will be left open for the minimum amount of time required for construction and will not pose a long-term hazard or barrier to stock. Impacts will be minimised through implementation of control measures described in Section 8.5. Temporary provisions such as fencing, gates etc or access to water will be discussed further with directly affected landholders and suitable arrangements implemented.

8.3.2 Community safety

Appropriate safety measures will be in place to protect the safety of the community during construction. Fencing, warning signs, and construction update information will be provided to reinforce these measures.

During operations the underground sections of the Mainland GTP will not represent a risk to community safety since the route will be marked with warning signs and above ground sections will be securely fenced.

8.3.3 Visual amenity

During construction, earthworks will be required which will involve the removal of vegetation. Much of the Mainland GTP RoW will be located in areas of grazing or cropping land where similar levels of visual change already occurs as a consequence of fencing, grazing, and cropping. Visual impacts on mature trees located in forest reserves will be greater but plantation timber is a managed resource. Most visual impacts will be temporary since the Mainland GTP will be buried underground and disturbed areas rehabilitated. Soil that is excavated will be stockpiled along the Mainland GTP RoW to be used to reinstate disturbed areas.

During operations, there will be mainline valves located along the Mainland GTP and each will be within a small compound of approximately 20 m x 50 m. These will continue to be visible once the Mainland GTP is underground.

8.3.4 Infrastructure

All infrastructure that will be affected due to crossings is listed in Section 8.2.6. The infrastructure and services crossed by the Mainland GTP RoW will be closely monitored to ensure risks are managed through management plans (eg, Contractors EMP (CEMP)) to minimise adverse impacts. Negotiations with affected infrastructure stakeholders is on-going, preliminary approvals have been obtained and approvals will be sought at design stage

In regards to rail and road, safety protocols will be implemented during any boring and/or drilling stages, or any ground entry points will be set back an appropriate distance so as to not interfere with rail or road infrastructure. The relevant stakeholders and local authorities will be consulted regarding construction methodology and the timing of construction.

There is similar potential for adverse impacts on powerlines where the Mainland GTP RoW is required to cross beneath powerlines. Construction activities will be undertaken after consultation with the relevant provider.

8.4 Cumulative impacts

Cumulative impacts on land tenure and use practices are described below. This cumulative impact assessment is based on the impact scope, identification and scoring methodology described in Chapter 2 of this EM Plan. The significance of cumulative impacts on land tenure and use is expected to be negligible to moderately negative.

8.4.1 Land tenure and use (mineral resources and extractive industry/timber milling)

The pipeline RoWs will cross several different land tenures, including land allocated for petroleum leases, exploration permits and mineral development leases.

All pipelines will impact on the Stuart Oil Shale mining lease, owned by Queensland Energy Resources Ltd.

The RoWs will intersect several state forests and conservation areas, including the Callide Timber Reserve, Calliope Forest Reserve and Targinnie State Forest. Loss of resources in the RoWs will be permanent.

While there is a cumulative impact associated with the combined loss of resources, this has been addressed in individual EISs prepared for each project and there are no construction environmental management measures available to address the impacts of loss of resource.

There will be minor negative cumulative impacts on land tenure and use (mineral resources and extractive industry/timber milling) from pipeline construction within the vicinity of the pipelines.

8.4.2 Land tenure and use (impacts on agricultural activities)

Pipeline construction may result in loss of agricultural soil capacity. The majority of the corridors consist of low grade pasture (GQAL Grade C2 or less). Cumulative impacts on GQAL are discussed in chapter 7 of this EM Plan.

Short term impacts from the construction of the pipelines through properties may result in disruption to cropping or grazing activities. Loss of crops may also occur, depending on the time of year that the pipelines are constructed through a particular property. In addition, there may be some larger properties where the construction of the pipeline may result in severance of cropping or grazing areas. This may lead to cumulative impacts where single properties are impacted by consecutive construction works.

A primary stock route runs inside the Callide Infrastructure Corridor (CIC) corridor just south of the intersection of the Bruce Highway and crosses the CIC at KP345, west of where the CIC crosses the Moura Short Line Railway. The stock route continues south along Dawson Highway, splitting at Bell Creek and continuing south towards Callide dam. Smaller stock routes are intersected by the CIC near the Moura Short Line Railway and south of Bell Creek. Cumulative impacts may arise to stock routes from restricted access and stock route closures, particularly if multiple closures on the primary stock route occur. Other cumulative impacts may arise from disturbance to vegetation and reduced water quality. Potential impacts resulting from the construction work will be short term as construction is anticipated to be less than five months in any given area.

Rural properties and stock routes will be rehabilitated according to each proponent's EM Plan. There may be some instances where pipeline infrastructure will require stock routes to be realigned or severed, however this will be covered in each project's EM Plan.

There will be minor negative cumulative impacts on land tenure and use (impacts on agricultural activities) from the pipelines. Potential additional mitigation measures that will be considered during the preconstruction and construction phases are:

- Consulting with local livestock farmers to identify any local stock routes that might be affected; and
- If stock crossings are required either during construction or operation, coordinating with other proponents so that stock crossings of each pipeline align and stock can cross the joint alignments by as short a route as possible.

8.4.3 Land tenure and use (public access)

The majority of the pipelines are to be co-located within existing easements where possible, minimising any cumulative impacts to land use and tenure. The common corridor for the pipelines is designated as the Northern Infrastructure Corridor (NIC), Western Corridor (WC) and the CIC. The CIC traverses part of the Callide Timber Reserve and the GSDA traverses

a small portion of the Targinnie State Forest. Public access will not be allowed to the CIC and GSDA corridors during construction.

Public access will be available during operations, except for certain timeframes when maintenance activities are done. Some fencing is likely to be retained around above ground infrastructure.

Since the CIC and GSDA corridors do not significantly impact recreational areas, cumulative impacts to public access are not anticipated.

There will be minor negligible permanent cumulative impacts on land tenure and use (public access) from the pipelines.

8.4.4 Visual amenity (lighting)

Construction working hours will be from 6:30 am to 6:30 pm. There will not be impacts from lighting at night.

8.4.5 Visual amenity (impacts on visual receptors)

Visual impacts are likely to occur where there are significant changes to the landscape character of the surrounding area.

The CIC and GSDA corridors can be described by three landscape character zones, as outlined in the EIS for the GLNG Project:

- LCZ 7 Callide River Valley defined by steep slopes, extensive grassland with scattered trees and woodland, views from the Burnett Highway and forest-covered ridge lines
- LCZ 8 Forest-covered Mountain Range, consisting of the Calliope River Valley with grassland and scattered woodland vegetation and forest-covered upper slopes and ridgelines
- LCZ 9 Gladstone Harbour Valley, which includes a broad valley formed by a central ridge and mountain range, the narrows waterway, industrial and urban developments and some woodland

Impacts on visual amenity may result from:

- Dust plumes and settlement of dust on vegetation
- Vegetation clearance leading to areas that will contrast with adjacent vegetated areas, particularly through the Callide and Calliope Ranges and forested areas
- General construction activities
- Trenching of the pipeline corridor, pipe stringing and stockpiling of soils

Higher visual impacts will occur in forested areas, particularly in the Callide Range. Sensitive receptors include:

- Local residents in the Callide River valley with views up to the Callide Range
- Travellers on the Dawson Highway and Gladstone-Mount Larcom Road
- Residences on Mount Alma Road and the Narrows Road
- Travellers and residents with views to the intersection of the Bruce Highway and the CIC, which is surrounded by remnant vegetation

Some residences in the surrounding valley may have reduced visual amenity for the construction phase, with cumulative impacts potentially extending up to 4 years.

Visual impacts from the construction of the RoWs will be temporary as the construction of the pipeline at any given location is expected to take one to two months, depending on weather conditions and landscape constraints.

Having multiple RoWs will intensify temporary visual impacts and could result in extended timeframes. Cumulative visual impact will relate to the duration of disturbance within the tightly defined corridors which could extend to 2 to 4 years.

In the longer term, the infrastructure corridor will generally be grassed and this will constitute a long term change to the landscape of the area in locations that were previously wooded.

There will be moderate negative permanent cumulative impacts on visual amenity (impacts on visual receptors) from the pipelines. Potential additional mitigation measures that will be considered during the preconstruction and construction phases of the Mainland GTP are:

- Coordinating with other proponents alignments in the vicinity of local residents and restoration plans to minimise overall visual impacts to recreational users.
- Identifying areas where strategic early rehabilitation / planting may shorten the periods of overall visual impacts.
- Coordinating rehabilitation to minimise the impacts of subsequent projects on earlier rehabilitation.

8.5 Environmental protection commitments, objectives and control strategies – land tenure and use

As described earlier in this chapter, the land directly affected by the Mainland GTP RoW is predominantly freehold land with a large number of private landholders. Environmental protection commitments, objectives and control strategies proposed for the management of land tenure and use are provided in Table 8.7 below.

Table 8.7 Summary of environmental protection commitments, objectives and control strategies – land tenure and use

Item	Detail
Environmental protection objective	<ul style="list-style-type: none"> • To minimise any social disruption to the local communities from the construction of the pipeline • To minimise potential impacts to third party infrastructure during the construction of the pipeline
Specific objectives	<ul style="list-style-type: none"> • No warranted complaints from landholders and the community, and warranted complaints responded to within 2 working days • Minimal interruption to third party infrastructure • No unauthorised impacts on third party infrastructure

Item	Detail
Control strategies	<p>Construction phase</p> <p><i>Landholders and land use</i></p> <ul style="list-style-type: none"> • GLNG Operations will plan to locate infrastructure such as pipelines, roads and wells so that they will not adversely impact on existing landholder management practices such as placement of farm infrastructure, fences and erosion management structures • Workers' accommodation must be located to the satisfaction of the DERM and have regard to potential noise emissions in accordance with Draft State Planning Policy: Air, Noise and Hazardous Materials • Permanent pipeline warning signs will be erected along the easement • Where practicable temporary exclusion fencing to restrict fauna access to the trench will be installed • Where required along the route, temporary fences will be installed to protect humans and livestock • Fences or other barriers will be installed where appropriate and where approved by the landholder to minimise unauthorised access • Property fences and gates will be installed, maintained and reinstated to a condition at least equal to the pre-existing condition • Landholder complaints will be recorded in a complaints register and appropriate corrective actions will be implemented and closed out by the Environmental Manager • Rehabilitation of disturbed areas will be undertaken progressively as works progress • Rehabilitation can be considered successful when it achieves the same pre disturbed land use and suitability class with no greater maintenance requirements (or as otherwise agreed in a written document with the landowner/holder and administering authority) is established <p><i>Community</i></p> <ul style="list-style-type: none"> • Contribute to local liveability programs and initiate a community consultation and awareness campaign to promote project benefits to the community <p><i>Visual amenity</i></p> <ul style="list-style-type: none"> • Existing roads and tracks will be used where practicable • Route alignment, location of accommodation facilities, storage and additional work areas and new access tracks will be based on, to the extent practicable, the following criteria: <ul style="list-style-type: none"> - Avoiding unduly steep or rugged terrain - Avoidance of areas of significant environmental value - Avoidance of areas subject to flooding - Avoidance of conflicting land uses - Maximise the use of existing roads and tracks - Minimise the width of tracks - Landholder requirements - Provision of adequate road access - Proximity to existing infrastructure

Item	Detail
	<ul style="list-style-type: none"> • Workers' accommodation must be located to the satisfaction of the DERM and have regard to potential noise emissions in accordance with Draft State Planning Policy: Air, Noise and Hazardous Materials <p><i>Infrastructure</i></p> <ul style="list-style-type: none"> • New tracks will be located as close to fences or property boundaries as possible subject to the requirements of the landholder • The location of the existing third party infrastructure in the RoW will be accurately identified on the alignment sheets and marked physically on the ground prior to trenching activities <p><i>Transport</i></p> <ul style="list-style-type: none"> • Equipment and material transport routes and storage areas will be planned in consultation with Gladstone Regional Council, Department of Environment and Resource Management (DERM), Gladstone Port Corporation, Maritime Safety Queensland (MSQ), and the Gladstone Economic and Industry Development Board to minimise disruption to road and other transport route users • GLNG Operations and the Contractor shall enter into an Agreement with Council identifying the likely issues associated with road infrastructure related to the Project. This Agreement will identify the contribution attributable to the project for its specific impact on road infrastructure and identify the means of mitigating this impact <p>Operational phase</p> <ul style="list-style-type: none"> • Typical mitigation and controls for the operational phase of the Project will be detailed in the Operational Management Plan, which will be developed prior to construction
<p>Performance indicators</p>	<ul style="list-style-type: none"> • Report on the performance in management of complaints to the Gladstone Regional Coordination Committee • The number of complaints received from stakeholders and the time taken to investigate, take suitable action and close out

9. Flora and fauna

9.1 Chapter summary

This chapter identifies the ecological attributes of the environment associated with the Mainland GTP RoW, with respect to both Commonwealth and State legislation, and the significance of these attributes from a local, regional, state and national perspective.

This chapter identifies the potential impacts that the Mainland GTP may have on local ecological values, and considers the potential cumulative impacts from a regional perspective. Mitigation measures for the protection of ecological values are outlined including management strategies to protect existing environmental values.

9.1.1 Summary of existing flora and fauna values

- A number of ecological assessments have been previously undertaken within and adjacent to the Mainland GTP RoW (refer Table 9.2)
- Flora surveys conducted along the RoW alignment focused on areas to be considered to be “ecologically sensitive areas (ESA)”
- A field-based fauna assessment was undertaken in anticipated areas of disturbance for the proposed Mainland GTP, and the surrounding areas
- The majority of the Mainland GTP RoW is situated within cleared land supporting grazing or cropping activities. The Calliope, Callide, Dawson, Expedition and Carnarvon ranges generally feature large expanses of bushland
- A number of flora and fauna related ESAs (category B and C) have been mapped by DERM as occurring within, and/or adjacent to the Mainland GTP RoW
- There are no internationally listed RAMSAR wetlands or Nationally important wetlands occurring within the Mainland GTP RoW
- The Mainland GTP RoW will not traverse any listed national parks, conservation parks, forest reserves or resource reserves, or nature refuges under the *Nature Conservation (Protected Areas) Regulation 1994*. However, under the provisions of the *Forestry Act 1959*, three category C ESAs are traversed by the RoW
- The Mainland GTP RoW supports approximately 33 Regional Ecosystem (RE) types (Table 9.5). The most common RE within the RoW is RE11.10.1 followed by RE11.11.15. The majority of the major creek crossings along the Mainland GTP RoW support RE11.3.25
- A review of environmental databases identified the potential for 39 flora species, listed as conservation significant under the provisions of the EPBC Act and/or the NC Act, to occur within a 5 km radius of the Mainland GTP RoW (Table 9.6)
- A species list of flora identified during previous surveys of the Mainland GTP RoW is provided in Table 9.7
- Thirteen threatened flora species listed under the provision of the EPBC Act and/or the NC Act were found within or directly adjacent the Mainland GTP RoW:
 - *Acacia gittinsii* (Gittins wattle) and *Acacia spania* (KP10.5)
 - *Acacia spania* (KP131)
 - Gittins wattle (KP141)
 - *Homoranthus decasetus* Red mouse bush (KP 140.25)
 - *Acacia pubicosta*, *Wahlenbergia islensis*, *Acacia tenuinervis* and *Apatophyllum teretifolium*
 - *Gonocarpus urceolatus* Raspweed (KP9.25)
 - *Acacia pedleyi* Pedley’s wattle (KP314.75)
 - *Bertya opponens* (KP20.5)
 - *Melaleuca irbyana* (Bushhouse paperbark) (KP11)
 - *Solanum johnsonianum* (KP243.25)

- *Cycas megacarpa* (Large-fruited zamia palm) (KP 314.5 – 329.25, KP 338.25, and KP 399 - 400)
- Table 9.9 outlines weed species detected within or adjacent to the Mainland GTP RoW during field investigations
- Approximately nine Type A restricted plants have been detected within the Mainland GTP RoW
- In total, 319 species, comprised of 22 amphibians, 52 reptiles, 195 birds, and 50 mammals have been detected within and/or adjacent to the Mainland GTP RoW (Table 9.11)
- Of the significant fauna and/or migratory/marine species listed in Table 9.10, five are known to occur within a 5 km radius of the Mainland GTP RoW
- The following threatened fauna species listed under the provision of the EPBC Act and/or the NC Act were identified from habitats within and adjacent to the Mainland GTP RoW:
 - the *Paradelma orientalis* (Brigalow scaly foot)
 - *Strophurus taenicauda* (Golden tailed gecko)
 - *Chalinolobus dwyeri* (Large-eared pied bat)
 - *Chalinolobus picatus* (Little pied bat)
- No conservation significant snake species were recorded
- The following threatened/vulnerable/priority fauna species may occur within the Mainland GTP RoW:
 - *Aspidites ramsayi* (Woma)
 - *Denisonia maculata* (Ornamental snake)
 - *Furina dunmalli* (Dunmall's snake)
 - *Acanthophis antarcticus* (Death adder)
 - *Rheodytes leukops* (Fitzroy River turtle)
 - *Elseya albagula* (White-throated snapping turtle)
 - *Dasyurus hallucatus* (Northern quoll)
 - *Taphozous australis* (Coastal sheath-tail bat)
 - *Petrogale herbeti* (Herbert's rock Wallaby)
- Five conservation significant bird species have been identified from habitats within and adjacent to the Mainland GTP RoW
- No *Phascolarctos cinereus* (Koalas) were observed during the survey periods
- No declared fish habitat areas (as defined under the provisions of the *Fisheries Act 1994*) occur within the Mainland GTP RoW

9.1.2 Summary of potential impacts to flora and fauna values

Construction

The construction of the Mainland GTP RoW is expected to generate a range of impacts relating to ESAs (refer Chapter 1), conservation significant fauna and flora, vegetation clearing, dust, weeds, edge effects, changes to fire regimes, erosion and sedimentation, loss of habitat, fauna injury and/or mortality, pests, noise and vibration, and lighting.

These impacts are considered to be relatively localised and the degree of impacts will likely be minimised to a manageable level with the implementation of appropriate measures described in Section 9.6, the SMP and SSMP.

Operation

From an operational perspective, vegetation disturbance impacts along the RoW are likely to be restricted to maintenance activities. Impacts from weed invasion, dust deposition, edge effects, erosion and sedimentation, loss of habitat/vegetation disturbance, noise and vibration, lighting and chemical use have been considered low and manageable. Minor impacts resulting from these activities will be managed through the SMP, SSMP and an OMP which will be developed prior to construction and implemented in all stages of the Project (construction, operation and decommissioning).

9.1.3 Summary of proposed mitigation measures

Table 9.1 Proposed mitigation measures for the management of flora and fauna

Item	Detail
Environmental Protection Objective	<ul style="list-style-type: none"> • Topsoil and vegetation material will be respread in the immediate vicinity of the area of origin to limit the potential spread of weeds and pathogens
Specific Objectives	<ul style="list-style-type: none"> • Minimal disturbance of terrestrial flora and fauna during construction of the pipeline, associated tracks, services and accommodation facilities • No unplanned or unapproved damage to flora and fauna • No overall net loss of threatened species or communities • To restore the RoW to be compatible with the surrounding conditions and pre-construction land use and compatible with the pipeline's operation • No spread of weeds and compliant with the Weed Management Plan • Reduce the likelihood of the spread of weeds • Control programs shall be prioritised to high risk areas adjacent to land of conservation significance
Control Strategies	Refer Table 9.15 for flora and fauna control strategies to be implemented during construction and operation of the Mainland GTP
Performance Indicators	<ul style="list-style-type: none"> • Minimal disturbance of terrestrial flora and fauna during construction of the pipeline, associated tracks, services and accommodation facilities • No unplanned or unapproved damage to flora and fauna • No spread of weeds and compliant with the Weed Management Plan or CEMP • No new weed infestation in the RoW as a result of construction or operational activities • Soils and vegetation stored appropriately to allow for restoration of disturbed areas to equivalent to surrounding area after construction • As a vehicle passes into a new zone (clean or dirty), a new sticker must be administered

9.2 Background

A number of ecological assessments (desktop and field-based) have been previously undertaken within and adjacent (ie <5 km) to the Mainland GTP RoW. Subsequently, various supplementary reports have been prepared (refer Table 9.2). A compilation of the results presented in these reports have been incorporated into this chapter of the EM Plan, where relevant.

Table 9.2 Ecological assessments within and adjacent to the Mainland GTP RoW

Date	Author	Report title	Assessment details
May 2008	URS	GLNG Project - Environmental Impact Statement	Comprehensive ecological survey of the GLNG RoW
September 2009	URS	GLNG Project - Environmental Impact Statement Supplement	Supplementary flora survey of the alternative RoW alignment options, identified following the completion of the EIS
June 2010	GHD	GLNG Pipeline Feed Weed Survey Report	Ecological surveys to establish the location of Class 1,2 and 3 weeds declared under the provisions of the LP Act and to provide maps indicating the distribution of declared weed species
October 2010	Ecologica Consulting	Significant Species Management Plan/Species Management Plan	Ecological survey within Endangered, Of Concern and Least Concern Regional Ecosystems within the GLNG RoW, focussing on the identification of threatened flora and fauna, and assessment of habitat values for Least Concern and conservation significant species

9.2.1 Previous survey methodologies

Flora

Previous field-based flora assessments, as identified in Table 9.2, have focussed on the anticipated areas of disturbance for the proposed Mainland GTP RoW. Combined, these assessments involved:

- Verification of the Regional Ecosystems (REs) mapping
- Targeted searches for significant flora species as listed under the provisions of the EPBC Act and NC Act
- Targeted searches for declared weed species as listed under the provisions of the *Land Protection (Pest and Stock Route Management) Act 2002* (LP Act)
- Verification of the extent, floristic structure and composition of vegetation communities
- Identification of the ecological values associated with the vegetation on the site
- Assessment of the diversity of terrestrial vascular flora within the study area and identification of ESAs
- Description of weed species and their distribution in the study area
- Identification of the potential impacts relating to the construction and operation of the Mainland GTP on the surrounding vegetation in order to develop appropriate management strategies

The flora surveys employed an assessment of floral taxa and RE mapping in keeping with the methodology employed by the Queensland Herbarium for the survey of REs and vegetation communities (Neldner *et al* 2005).

A number of standard botanical assessment methods were employed including secondary transects, quaternary sample plots, and random meander searches.

Community structural formation classes were assessed according to Neldner *et al.*, 2005. RE classification of communities was determined as per Sattler and Williams (1999), and in accordance with the Regional Ecosystem Description Database (REDD) Version 6.0b (DERM, 2011). Final vegetation mapping was undertaken utilising field survey data and aerial photograph interpretation of stereo pair images at a scale of approximately 1:22,000 (Aerometrex, 2008).

The EIS flora assessments for the Mainland GTP RoW were undertaken during two survey periods; over the course of 20 days, between 30 June and the 25 July 2008; and over a five day period between the 6 October and 10 October 2008 (dry season). There were 54 quaternary and 41 secondary sites (Neldner et al., 2005) assessed within the Mainland GTP RoW (URS, 2008).

The SEIS Flora assessment was conducted along the revised RoW alignment over seven days between 31 August and 6 September 2009. There were 28 sites assessed during the SEIS flora survey.

A subsequent flora survey was conducted within the revised Mainland GTP RoW in August-September 2010, by Ecologica Consulting (2010).

The flora assessments primarily focussed on areas considered to be “ecologically sensitive areas” (EcoSAs) along the RoW. These areas were classified as meeting one or more of the following criteria:

- Supporting ‘Endangered’ or ‘Of Concern’ or ‘Least Concern’ REs (as identified by DERM mapping)
- Supporting remnant vegetation
- Supporting mapped ‘Endangered’ and ‘Of Concern’ High Value Regrowth
- Known habitat for conservation significant flora species
- RE polygons mapped by DERM as containing Essential Habitat areas for species listed as significant under the provisions of the NC Act

Fauna

A comprehensive fauna survey was conducted for a small portion of the Mainland GTP RoW by URS in 2008 as part of the EIS. The field-based fauna assessments focused on the anticipated areas of disturbance for the proposed Mainland GTP, and the surrounding areas (URS, 2008).

Where dense vegetation precluded access to the RoW, alternative sites were chosen to reflect similar dominant vegetation communities based on ease of access (ie site analogs). The surveys sampled principal habitat types within the vicinity of the RoW, based on knowledge of the site gained during the desktop assessment, aerial photograph interpretation and a scoping foray.

Fauna surveys were undertaken in keeping with the accepted standard methods for the systematic survey of terrestrial fauna in eastern Australia (Eyre *et al*, 1997 and EPA, 1999) and a number of non-standard observational methods (URS, 2008).

Fauna assessments primarily focussed on targeted searches for conservation significant species (including Koala) as listed under the provisions of the EPBC Act and/or the NC Act, identification of suitable habitat (including aquatic) for Least Concern and conservation significant species, anabat recording and trace identification (ie scats, scratches etc). Incidental species encountered (including fly-overs) were also recorded.

The EIS fauna surveys of the Mainland GTP RoW were undertaken concurrently with the Mainland GTP RoW flora surveys, as described above (URS, 2008).

Incidental fauna surveys were conducted along the revised Mainland GTP RoW in August-September 2010 by Ecologica Consulting (2010).

9.2.2 Limitations to previous survey methodology

Field Surveys

Data acquisition during flora surveys has inherent limitations associated with variability of vegetation communities and species detectability as a result of spatial and temporal factors. All survey sites were strategically located to capture representative samples of communities, and the seasonal conditions during which the survey was undertaken coincided with maximal floral species detectability. However, flora surveys conducted within the Mainland GTP RoW cannot account for 100 per cent of potential floral diversity present.

Similarly, all fauna surveys are subject to inherent limitations in the detection success of target species. Some fauna species may become more cryptic (ie harder to find) or are transient species that typically become absent during certain periods due to a variety of reasons (eg weather conditions, absence of food sources, migratory nature). For migratory or nomadic species not recorded during field investigations, habitat assessments have been completed to determine the likelihood of their occurrence within, or adjacent to the Mainland GTP RoW.

These limitations often result in a degree of false-absence records (ie a species is present, but not detected). It is important, therefore, that the limitations to fauna surveys are identified and the fauna survey results are viewed with these constraints in mind.

A summary of the limitations to the fauna surveys conducted include:

- The survey period not coinciding with the period that some migratory or nomadic species occur in the locality
- Species with large home ranges (eg owls and raptors) are not present in this part of their home range during the survey period
- The difficulty in detecting certain species during the survey period (eg cryptic species, species present in the study area at very low densities, and trap-shy species)
- Biological factors such as sex, age-class, and breeding biology, which may influence species' habitat use and detectability during different times of the year
- The lack of suitable climatic conditions necessary for the presence and/or detectability of certain species (eg amphibians following heavy rainfall)

Database results

Caveats are attached to the information gained from database searches including Wildlife Online and the EPBC Act Protected Matters Search Tool (provided DSEWPC).

The Wildlife Online database search (provided by DERM) is primarily based on flora and fauna specimens that have been actually identified and recorded for a defined area(s). Thus, the absence of specimen records for a particular species does not indicate that the species does not occur in the area. Furthermore, species records may be dated, and thus may not provide an accurate representation of the species currently found within the region.

Results of the EPBC Act Protected Matters Search Tool is based on a combination of actual records (primarily from State Government databases), combined with modelled distributions of species according to their ecological characteristics. Not all species listed under the EPBC Act have been modelled and therefore the EPBC Act Protected Matters report is to be used as a general guide only.

Species record data received through the Queensland Museum and Queensland Herbarium (HERBRECS) may vary in precision (accuracy) up to approximately 100 km in some cases. Furthermore, some of the species records may be dated (ie pre 1950), and thus may not provide an accurate representation of species that currently exist within the region.

9.3 Existing ecological environment

9.3.1 Regional and site context

The Mainland GTP RoW is situated within the Brigalow Belt bioregion (ie bioregion 11) (Sattler and Williams, 1999). The Mainland GTP RoW falls within several sub-regions within the Brigalow Belt including the Mount Morgan Ranges, Callide Creek Downs, Banana-Auburn Ranges, Dawson River Downs, Arcadia, and Carnarvon Ranges.

The Mainland GTP RoW traverses a range of landforms and land uses. The majority of the route (approximately 83%) is situated within cleared land supporting grazing or cropping activities. The Calliope, Callide, Dawson, Expedition and Carnarvon ranges generally feature large expanses of bushland with various degrees of integrity. Isolated patches of bushland exist as open woodland, often along and adjacent to the waterways. Much of the bushland is held in forestry leases with typical uses being commercial timber harvesting and grazing. The field survey indicated bushland on privately owned land is generally grazed.

The remnant vegetation that is present is largely restricted to the range crossings of the Calliope Range, Callide Range, Dawson Range, Expedition Range and Carnarvon Range. Major watercourses such as the Dawson River have also retained a significant amount of remnant riparian vegetation. DERM RE mapping indicates 33 RE types occurring within the Mainland GTP RoW, however this may vary due to mapping inaccuracies and incomplete surveys. . All of the vegetation associations surveyed have been disturbed or modified to some degree by grazing, thinning, clearing for agriculture or weed invasion.

As discussed in Chapter 1, and in accordance with the CSG Guidelines, ESAs within and adjacent to the Mainland GTP RoW have been considered.

A number of flora and fauna related ESAs (category B and C) have been mapped by DERM as occurring within, and/or adjacent to the Mainland GTP RoW (Figure 9.1), namely:

- Endangered regional ecosystem – category B
- Of Concern regional ecosystem – category C
- Essential habitat – category C
- State forests and timber reserves – category C

These ESAs are discussed further in Sections 9.3.2, 9.3.3 and 9.3.4.

9.3.2 Protected areas

International and National important wetlands

There are no internationally listed RAMSAR wetlands within the Mainland GTP RoW. Furthermore, no Nationally important wetlands occur within the Mainland GTP RoW. However, as discussed in Chapter 14, the National Directory of Important Wetlands in Australia (DIWA) lists four Nationally important wetlands (refer Table 9.3) within the adjacent regions (<15 km) of the RoW (Environment Australia, 2001).



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 50km
- 10km

Environmentally Sensitive Areas

- Category A
- Category B
- Category C
- Cadastral
- Rail
- Watercourse
- Major Road

Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Cadastral: Department of Management and Resource Management, Jun 2011.
 Environmentally Sensitive Areas: Santos, Feb 2011.

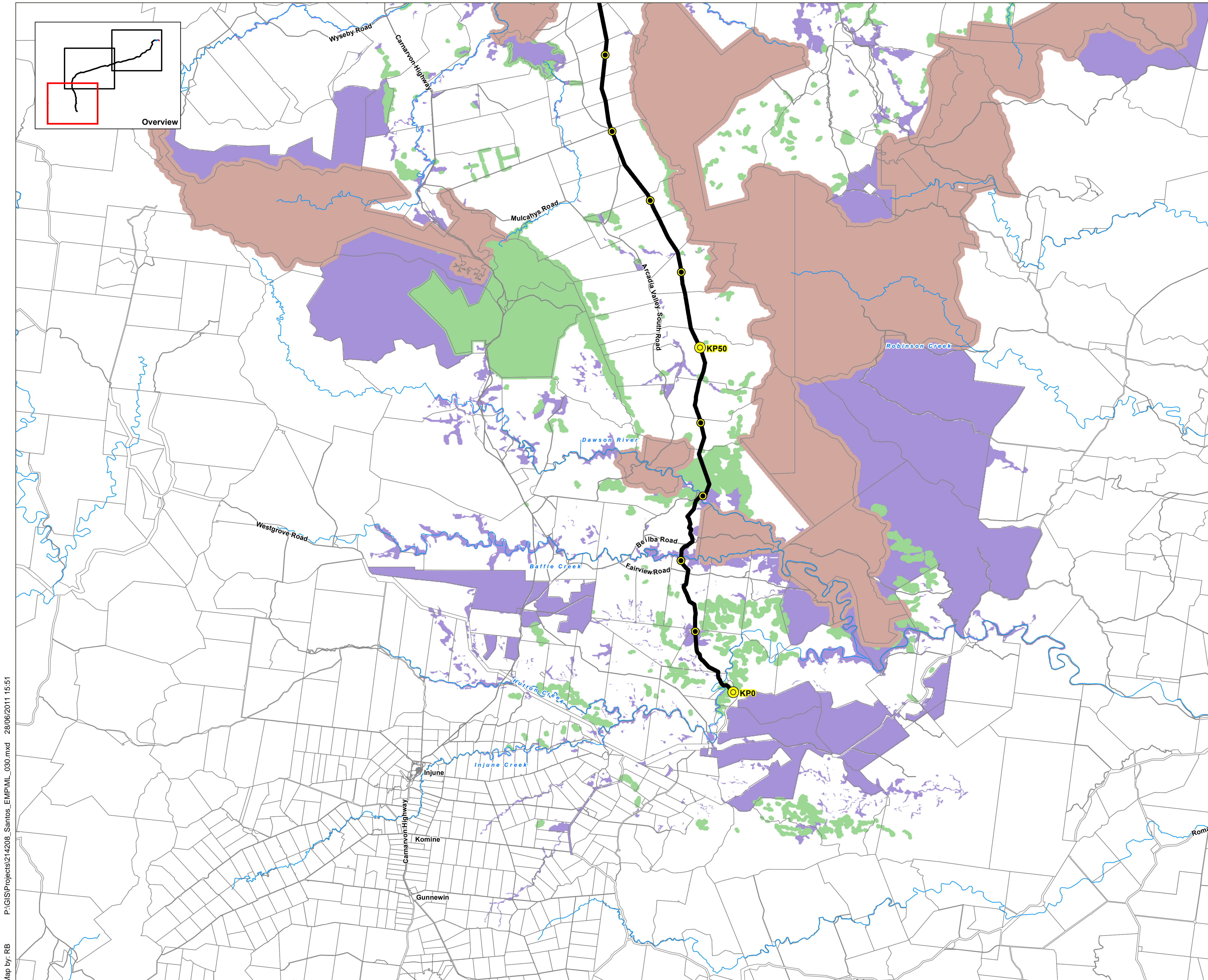
Note: The Category A Environmentally Sensitive Area was originally provided by Santos, however has been redefined based on a directive from Santos to remove an illustrative 500m buffer.

Environmentally Sensitive Areas

Figure 9.1 (Page 1 of 3)

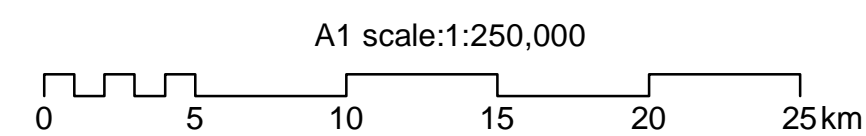
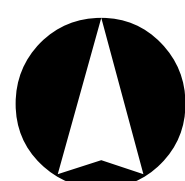
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Map by: RB



GLNG No: 3381-40-0423
 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

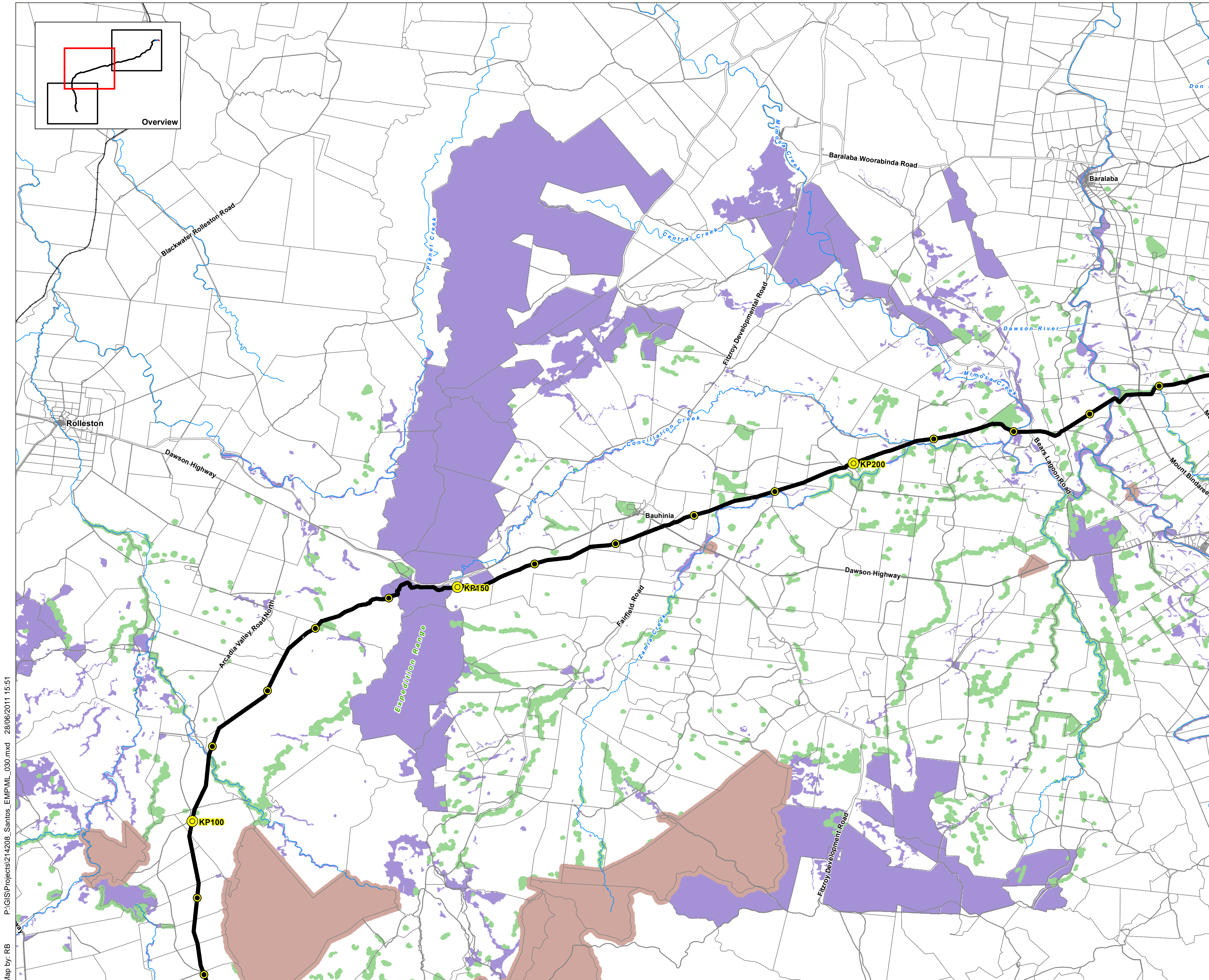
- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 50km
- 10km

Environmentally Sensitive Areas

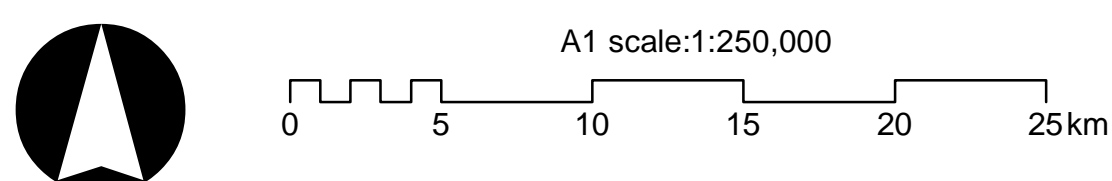
- Category A
- Category B
- Category C
- Cadastral
- Rail
- Watercourse
- Major Road



Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Cadastral: Department of Management and Resource Management, Jun 2011.
 Environmentally Sensitive Areas: Santos, Feb 2011.

Note: The Category A Environmentally Sensitive Area was originally provided by Santos, however has been redefined based on a directive from Santos to remove an illustrative 500m buffer.

Environmentally Sensitive Areas
Figure 9.1 (Page 2 of 3)





Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

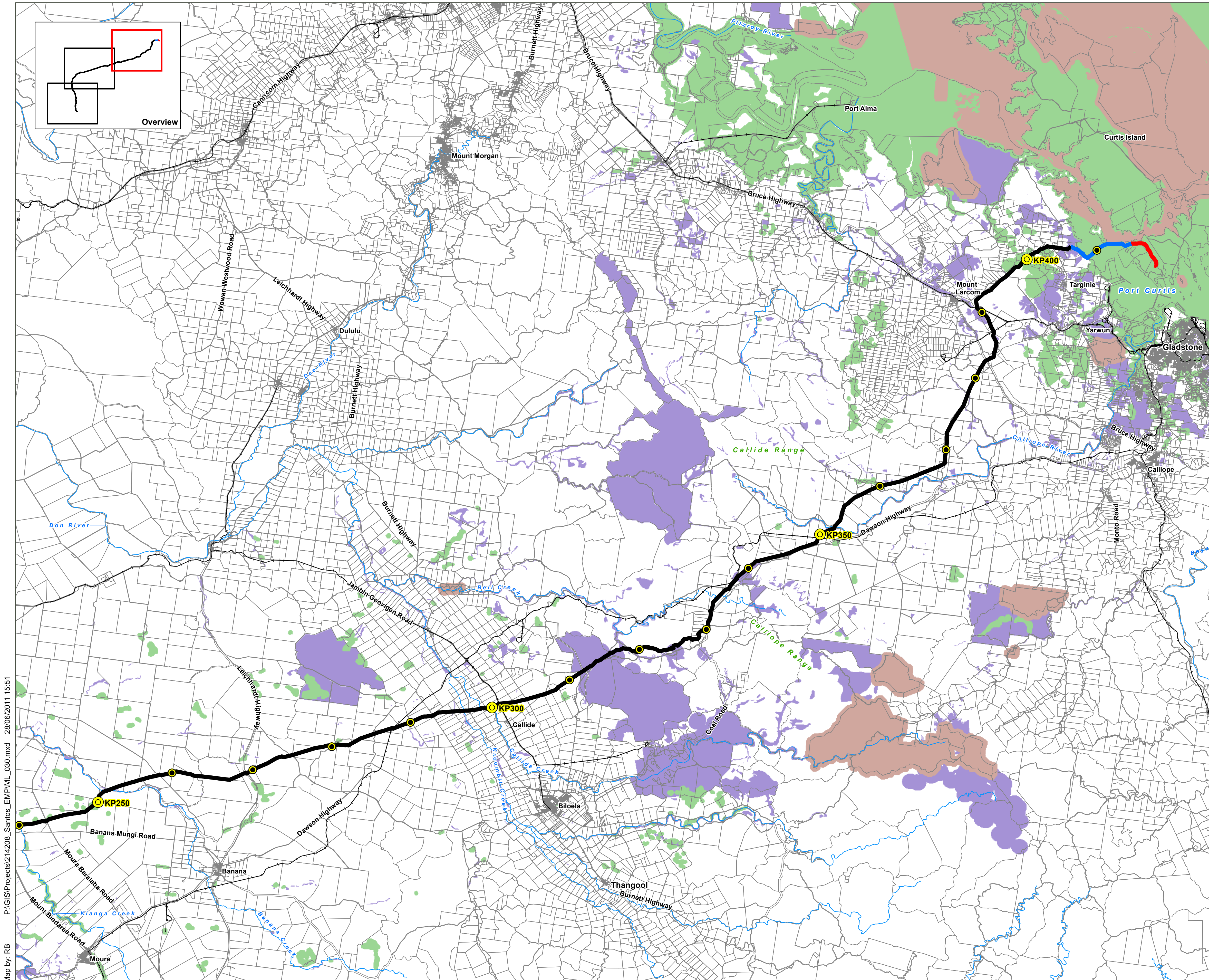
- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 50km
- 10km

Environmentally Sensitive Areas

- Category A
- Category B
- Category C
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- Rail
- Watercourse
- Major Road



Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Cadastral: Department of Management and Resource Management, Jun 2011.
 Environmentally Sensitive Areas: Santos, Feb 2011.

Note: The Category A Environmentally Sensitive Area was originally provided by Santos, however has been redefined based on a directive from Santos to remove an illustrative 500m buffer.

Environmentally Sensitive Areas
Figure 9.1 (Page 3 of 3)

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These wetlands are considered Nationally important as they meet at least one of the following criteria:

- a) It is a good example of a wetland type occurring within a biogeographic region in Australia
- b) It is a wetland which plays an important ecological or hydrological role in the natural functioning of a major wetland system/complex
- c) It is a wetland which is important as the habitat for animal taxa at a vulnerable stage in their life cycles, or provides a refuge when adverse conditions such as drought prevail
- d) The wetland supports 1% or more of the national populations of any native plant or animal taxa
- e) The wetland supports native plant or animal taxa or communities which are considered endangered or vulnerable at the national level
- f) The wetland is of outstanding historical or cultural significance

Table 9.3 Nationally important wetlands within the broader region

Nationally important wetland	Approximate Location	Criterion for inclusion
Lake Nuga Nuga	4.7 km W of KP 89.75	1, 3
Fitzroy River Delta	14.5 km NNW of KP 393.25	1, 2, 3, 6
Port Curtis	2.7 km SE of KP 406	1-6
The Narrows	0.8 km E of KP 406	1, 2, 3, 6

Table notes: Source: Environment Australia (2001)

Parks, forests, reserves and conservation estates

As indicated by the *Nature Conservation (Protected Areas) Regulation 1994* (NCPA Reg), the Mainland GTP RoW will not traverse any listed national parks, conservation parks, forest reserves or resource reserves or nature refuges.

Furthermore, under the provisions of the *Forestry Act 1959* (Forestry Act), feature protection areas, State forest parks or scientific areas are not mapped within the Mainland GTP RoW.

However, under the provisions of the Forestry Act, three State reserves/forests are intercepted by the RoW (refer Table 9.4 and Chapter 8). These areas are recognised as a category C ESA (refer Figure 9.2).

Table 9.4 State Forests and Timber Reserves within the Mainland GTP RoW

Estate name	ESA Category	Approximate location	Approximate area within RoW (ha)
Expedition State Forest	C	KP 141-149.25	24.2
Callide Timber Reserve	C	KP 311.5-316	12.5
Targinnie State Forest	C	KP 404.75	1.0

A number of additional protected areas/estates occur within the broader region (ie within 10 km of the RoW; DERM, 2010):

- Hallett State Forest
- Beliba State Forest
- Expedition (Limited Depth) National Park
- Nuga Nuga National Park
- Mount Nicholson State Forest
- Zamia Creek Conservation Park
- Overdeen State Forest
- Callide Range State Forest



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

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- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 50km
- 10km

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- Of Concern - dominant
- Of Concern - sub-dominant
- Not of Concern

High Value Regrowth Vegetation

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- Of Concern Regional Ecosystem
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Regional Ecosystem where VM and BD status differ

- Regional Ecosystem where VM and BD status differ

EPBC Threatened Species/ Ecological Community

- EPBC Threatened Species/ Ecological Community

Essential Habitat

- Essential Habitat

Essential Regrowth Habitat

- Essential Regrowth Habitat

EVNT Threatened Species

- Acacia gittinsii*
- Acacia pedleyi*
- Acacia pubicosta*
- Acacia spania*
- Apatophyllum teretifolium*
- Bertya opposens*
- Cycas megacarpa*
- Gonocarpus urceolatus*
- Homoranthus decasetus*
- Melaleuca irbyana*
- Solanum johnsonianum*

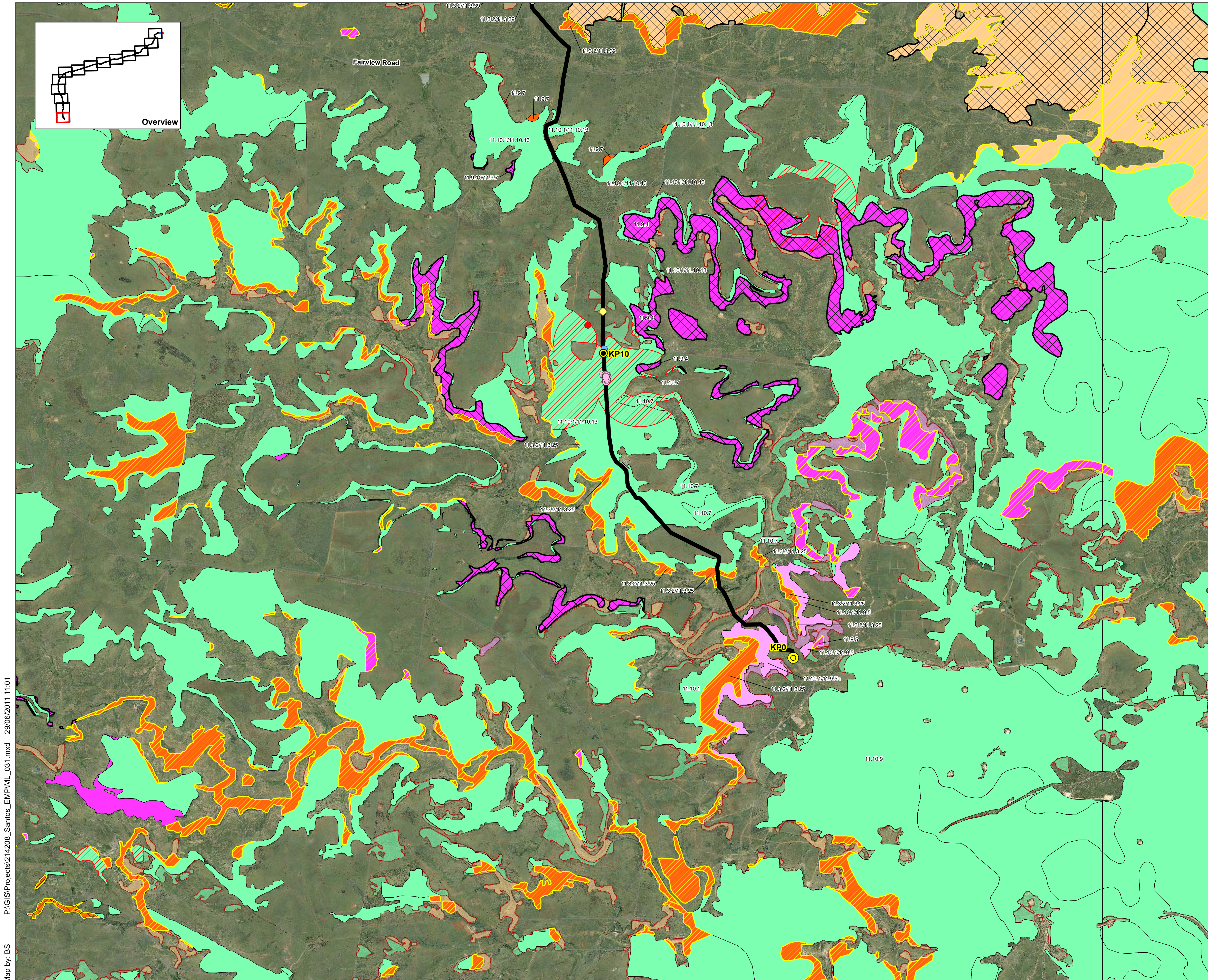
Bioregions

Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Regional Ecosystems: Version 6, The State of Queensland (Department of Environment and Resource Management), Nov 2009.
 High Value Regrowth Vegetation: Version 2, The State of Queensland (Department of Environment and Resource Management), Nov 2009.
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Regional Ecosystems, High Value Regrowth Vegetation and Essential Habitats
Figure 9.2 (Page 1 of 14)

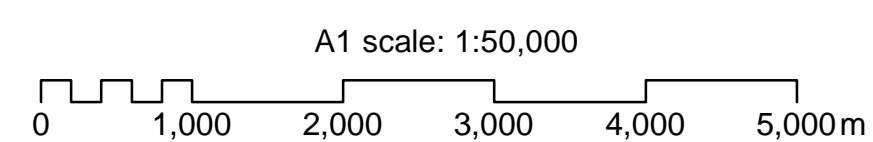
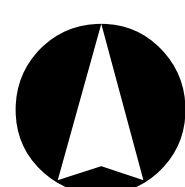
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Map by: BS



GLNG No: 3381-40-0424
 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

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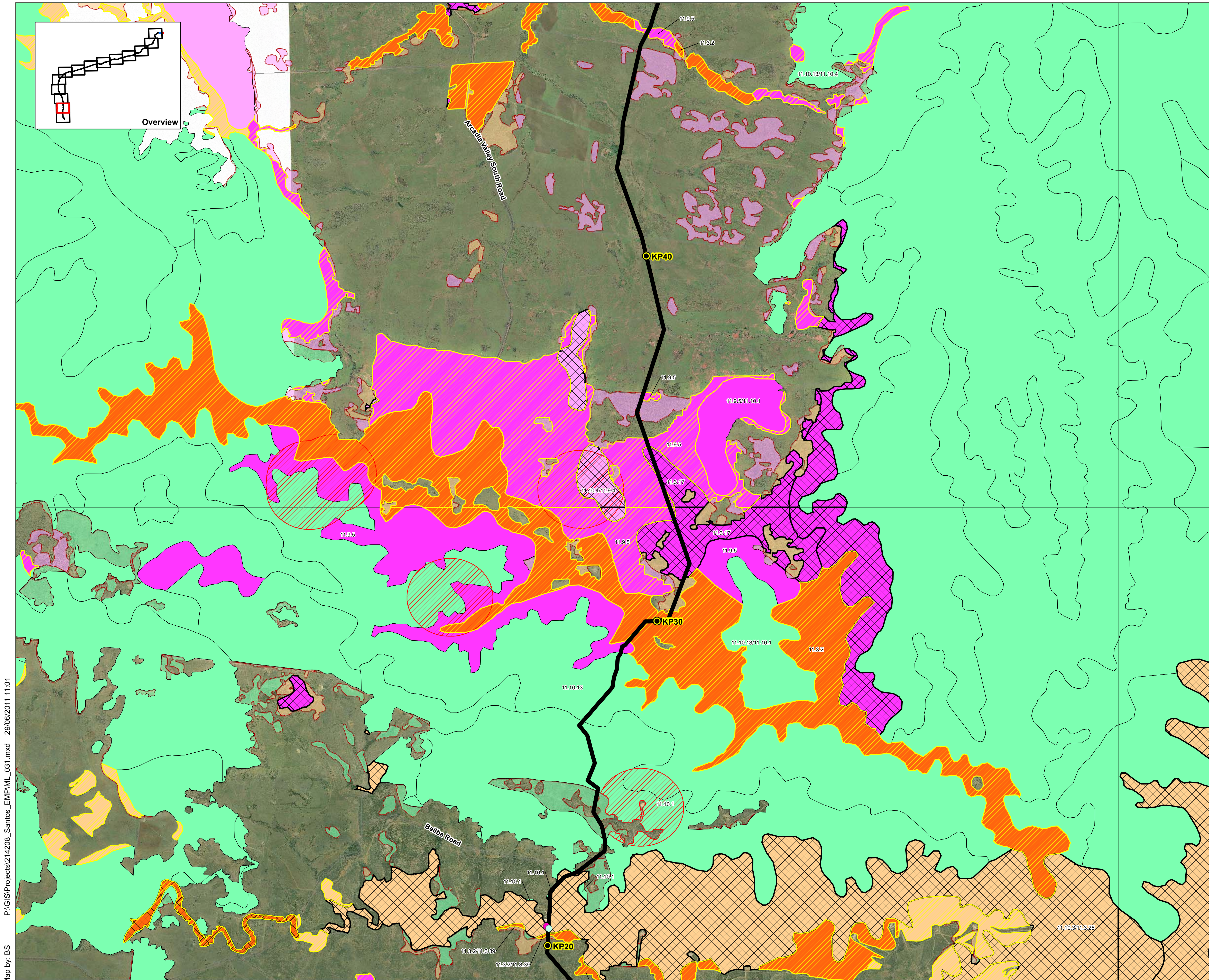
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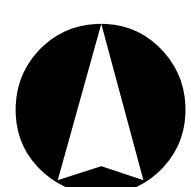
Regional Ecosystems, High Value Regrowth Vegetation and Essential Habitats
Figure 9.2 (Page 2 of 14)

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Version: c



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 Map by: BS



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GLNG No: 3381-40-0424
 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

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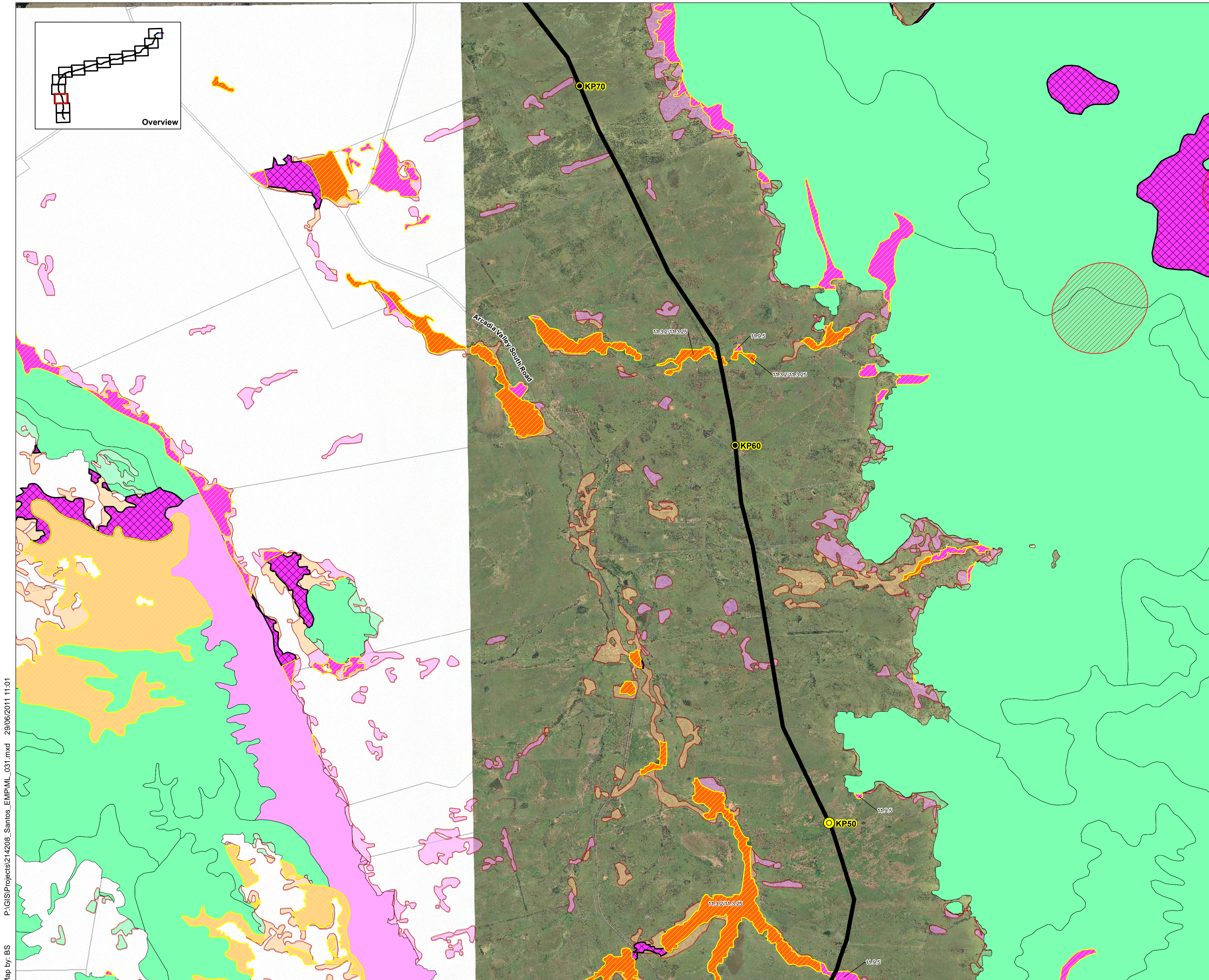
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Regional Ecosystems, High Value Regrowth Vegetation and Essential Habitats

Figure 9.2 (Page 3 of 14)

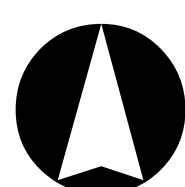
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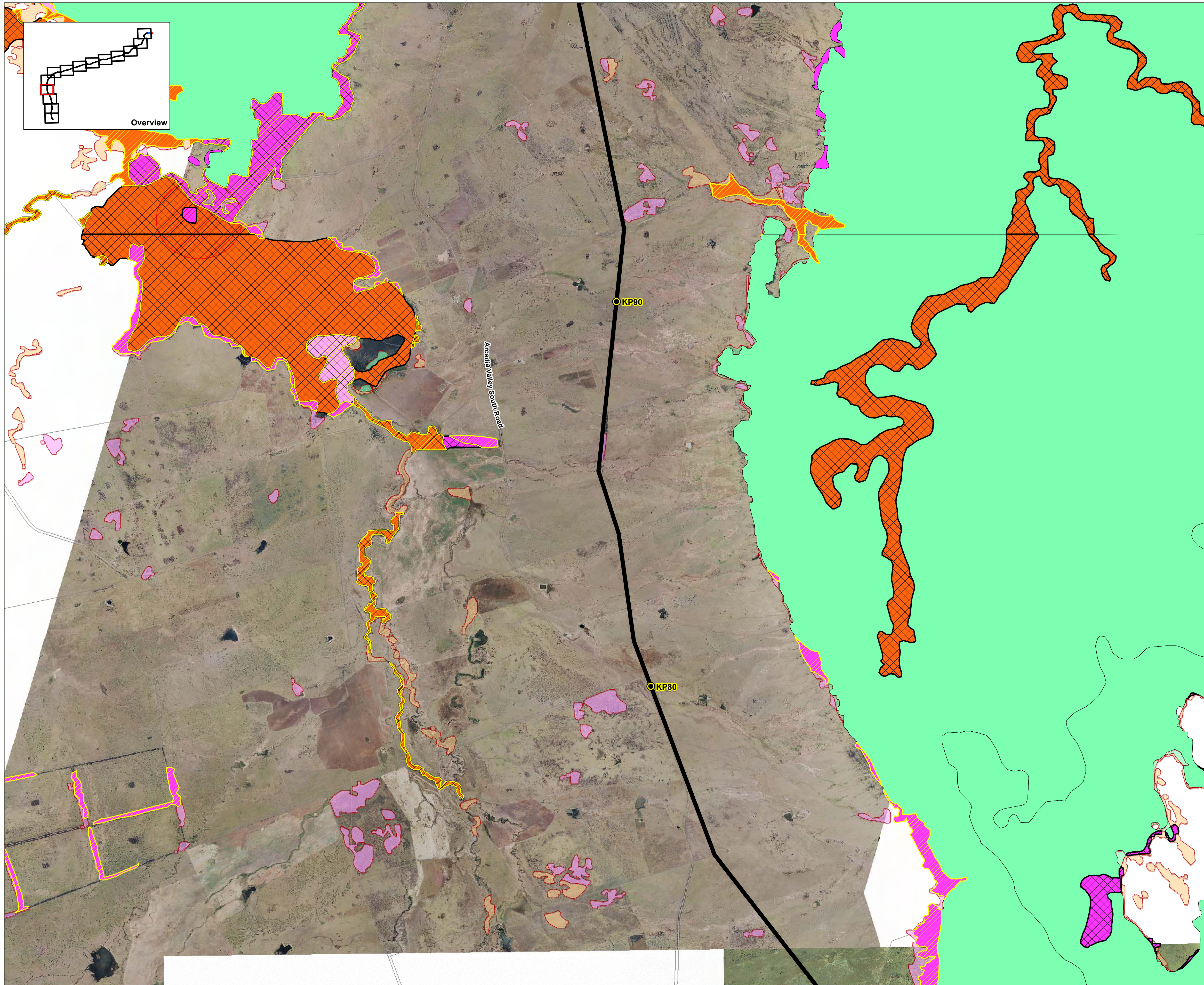
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Regional Ecosystems, High Value Regrowth Vegetation and Essential Habitats
Figure 9.2 (Page 4 of 14)

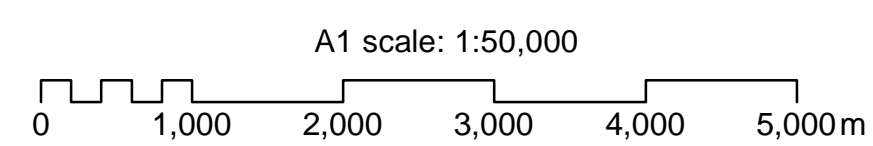
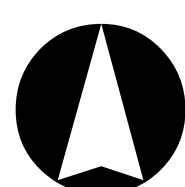
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Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

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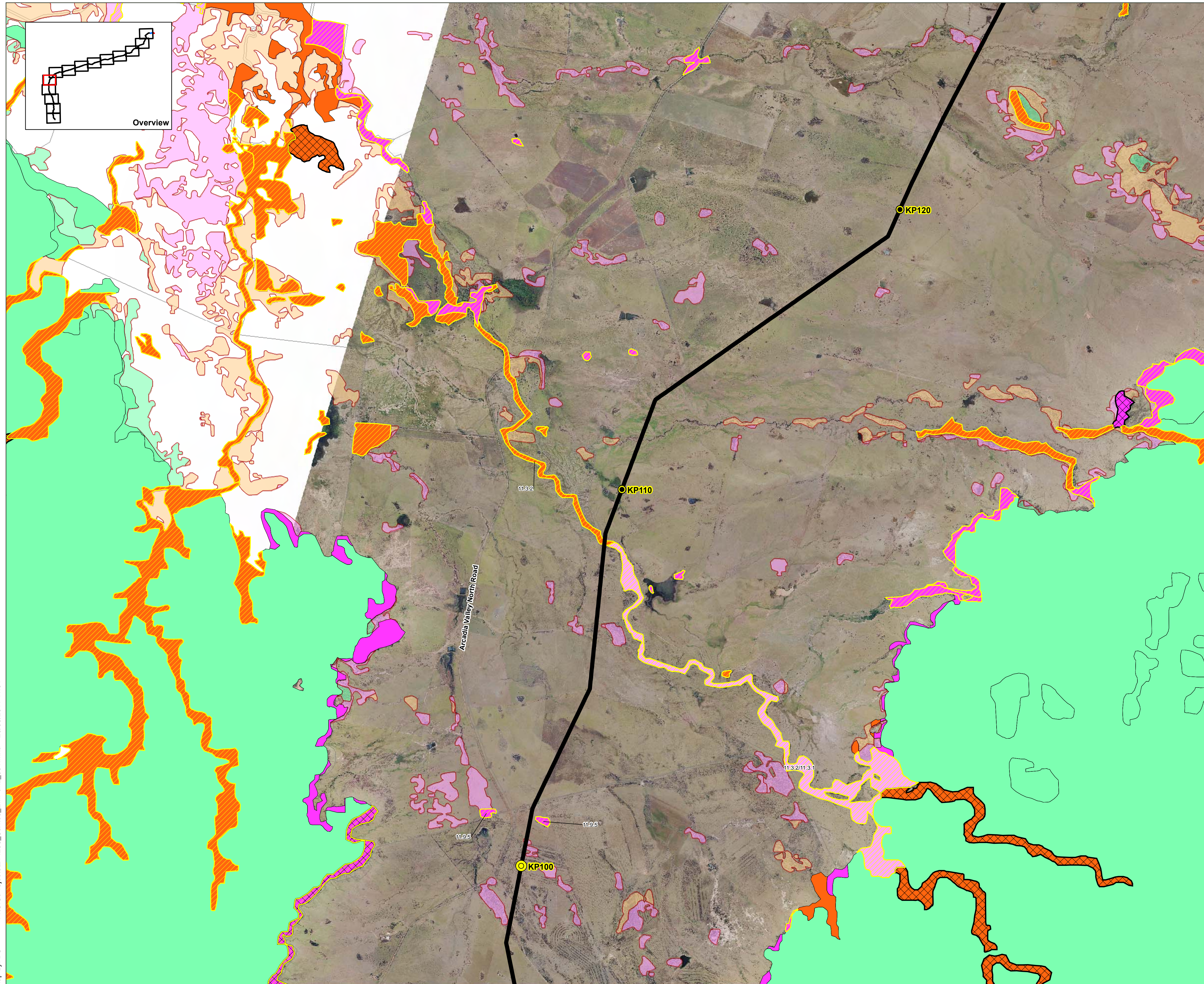
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Regional Ecosystems, High Value Regrowth Vegetation and Essential Habitats

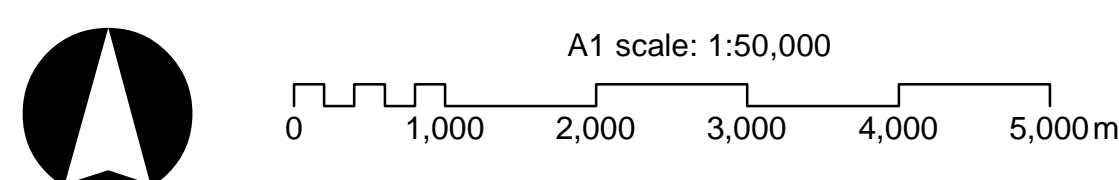
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Mainland GTP EM Plan

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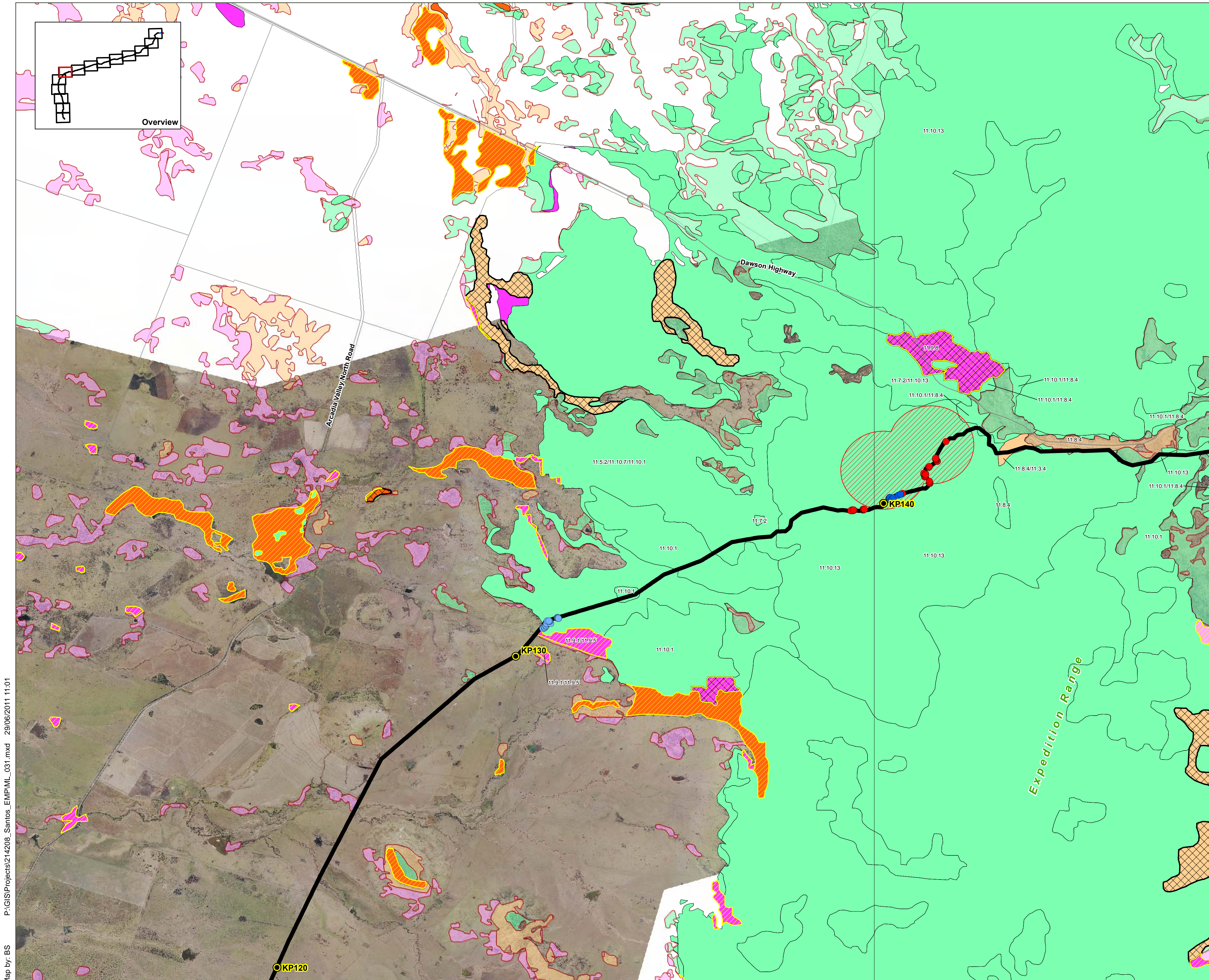
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Regional Ecosystems, High Value Regrowth Vegetation and Essential Habitats
Figure 9.2 (Page 6 of 14)

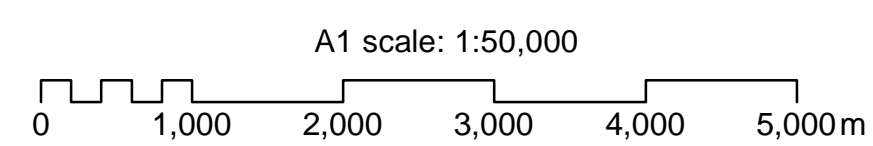
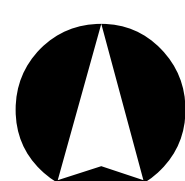
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Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

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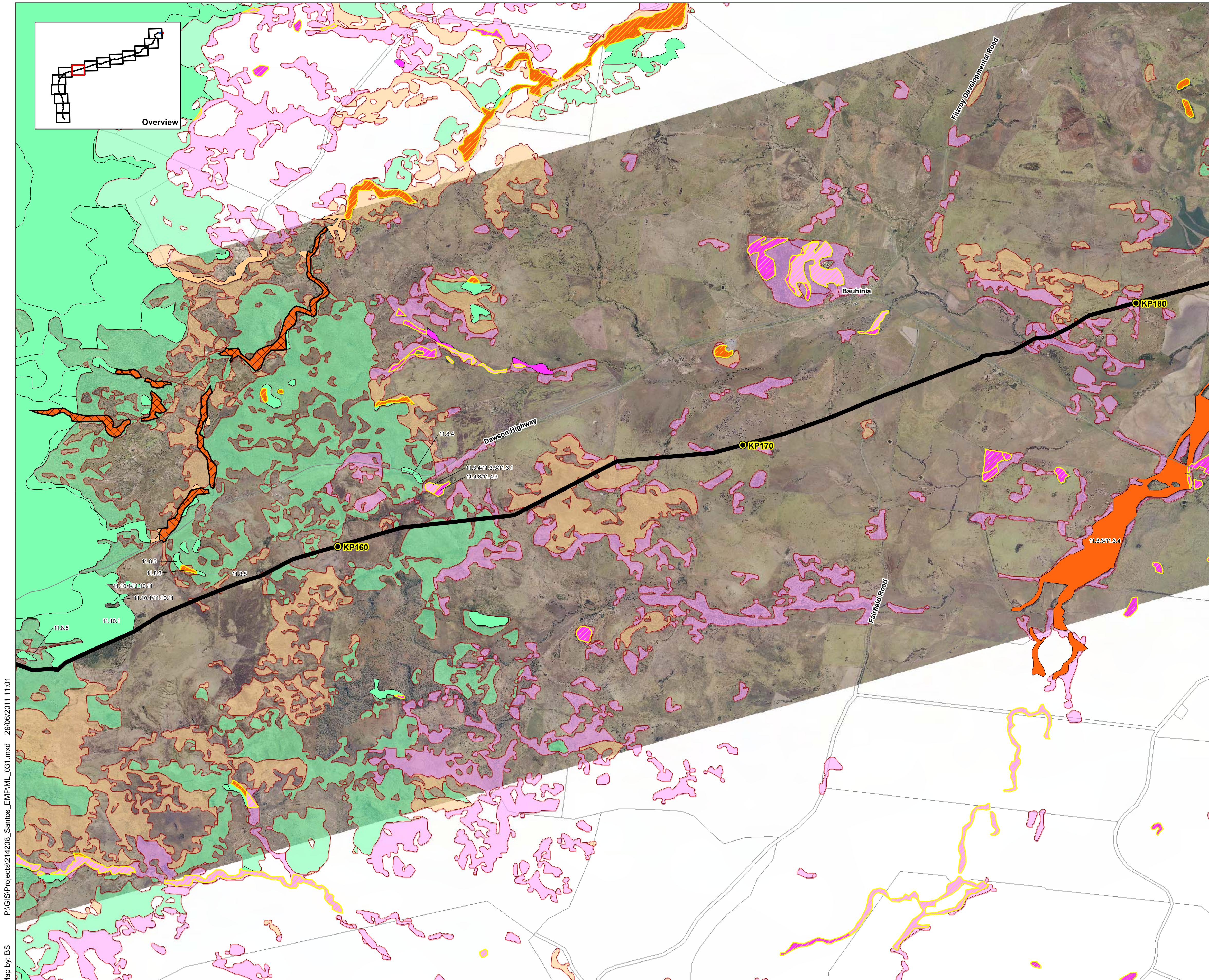
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Regional Ecosystems, High Value Regrowth Vegetation and Essential Habitats

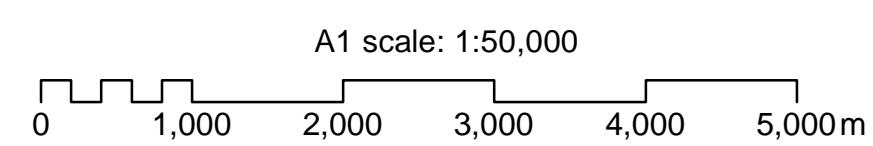
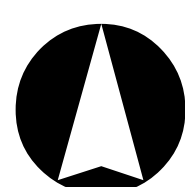
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Mainland GTP EM Plan

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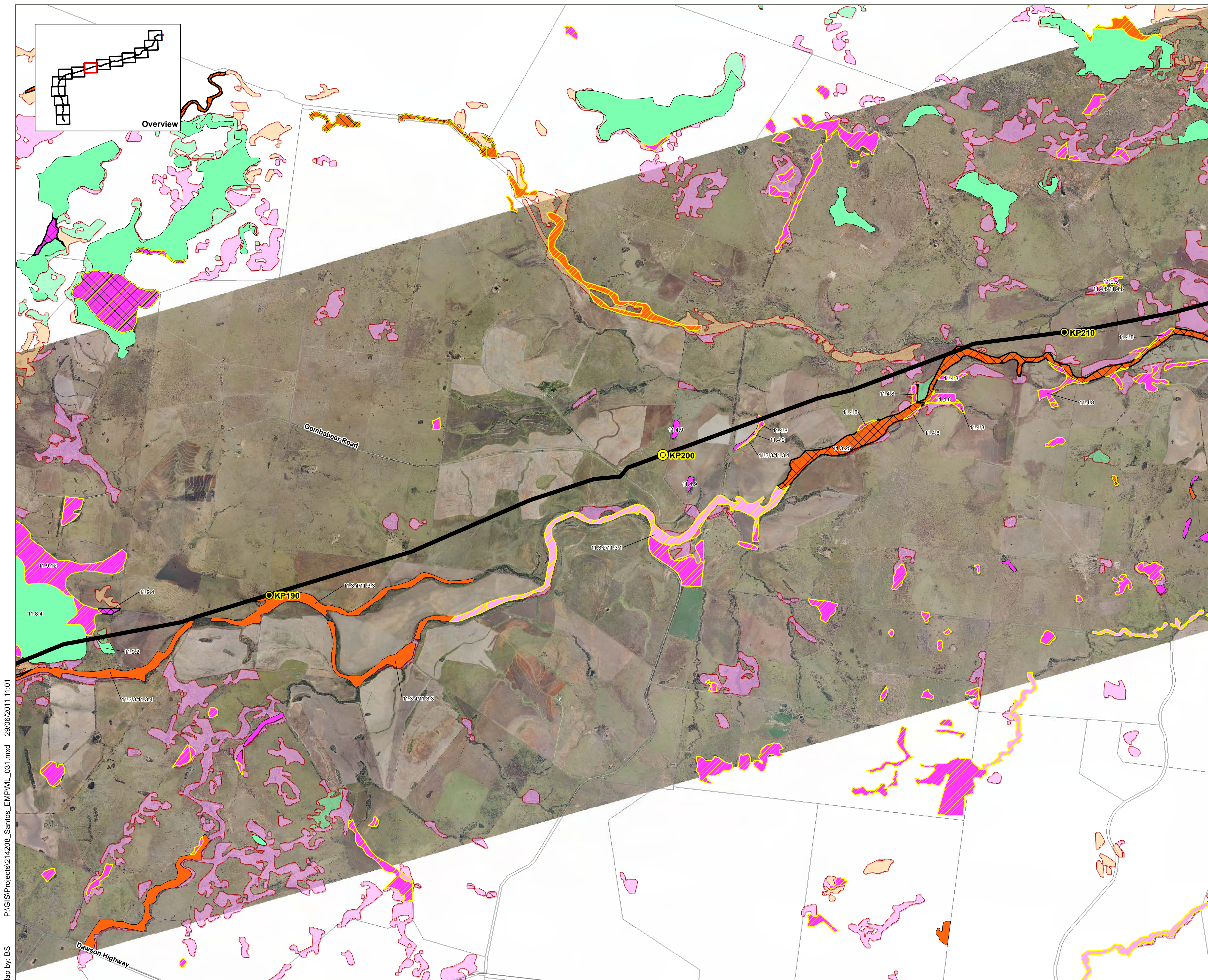
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Regional Ecosystems, High Value Regrowth Vegetation and Essential Habitats

Figure 9.2 (Page 8 of 14)

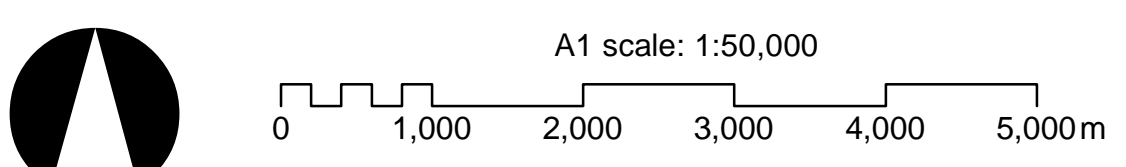
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- Apatophyllym teretifolium*
- Bertya opposens*
- Cycas megacarpa*
- Gonocarpus urceolatus*
- Homoranthus decasetus*
- Melaleuca irbyana*
- Solanum johnsonianum*

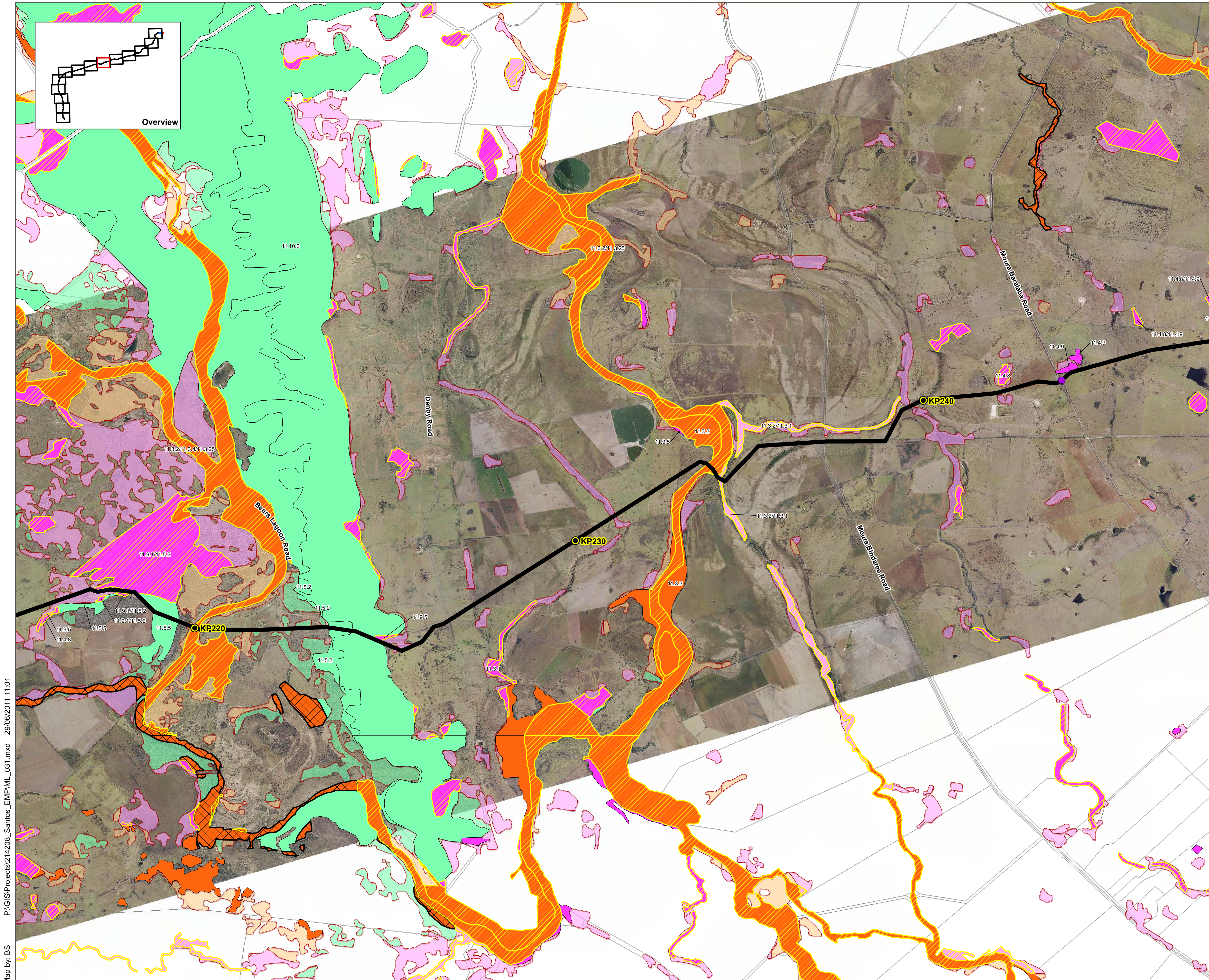
Bioregions

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 Regional Ecosystems: Version 6, The State of Queensland (Department of Environment and Resource Management), Nov 2009.
 High Value Regrowth Vegetation: Version 2, The State of Queensland (Department of Environment and Resource Management), Nov 2009.
 Aerial: Santos, Feb 2011.
 EPBC Threatened Species and Ecological Community: Department of the Environment, Water, Heritage and the Arts, 2010.
 Threatened Species: Aurecon Field Data, 2010.
 Bioregions: Version 5, Department of Environment and Resource Management, Feb 2011.

Regional Ecosystems, High Value Regrowth Vegetation and Essential Habitats Figure 9.2 (Page 9 of 14)

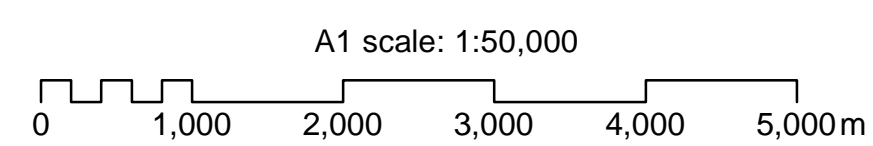
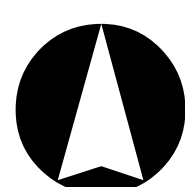
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Map by: BS



GLNG No: 3381-40-0424
 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 50km
- 10km

Regional Ecosystem - Biodiversity Status

- Endangered - dominant
- Endangered - sub-dominant
- Of Concern - dominant
- Of Concern - sub-dominant
- Not of Concern

High Value Regrowth Vegetation

- Endangered Regional Ecosystem
- Of Concern Regional Ecosystem
- Least Concern Regional Ecosystem

- Regional Ecosystem where VM and BD status differ

- EPBC Threatened Species/ Ecological Community

- Essential Habitat

- Essential Regrowth Habitat

EVNT Threatened Species

- Acacia gittinsii*
- Acacia pedleyi*
- Acacia pubicosta*
- Acacia spania*
- Apatophyllym teretifolium*
- Bertya opposens*
- Cycas megacarpa*
- Gonocarpus urceolatus*
- Homoranthus decasetus*
- Melaleuca irbyana*
- Solanum johnsonianum*

- Bioregions

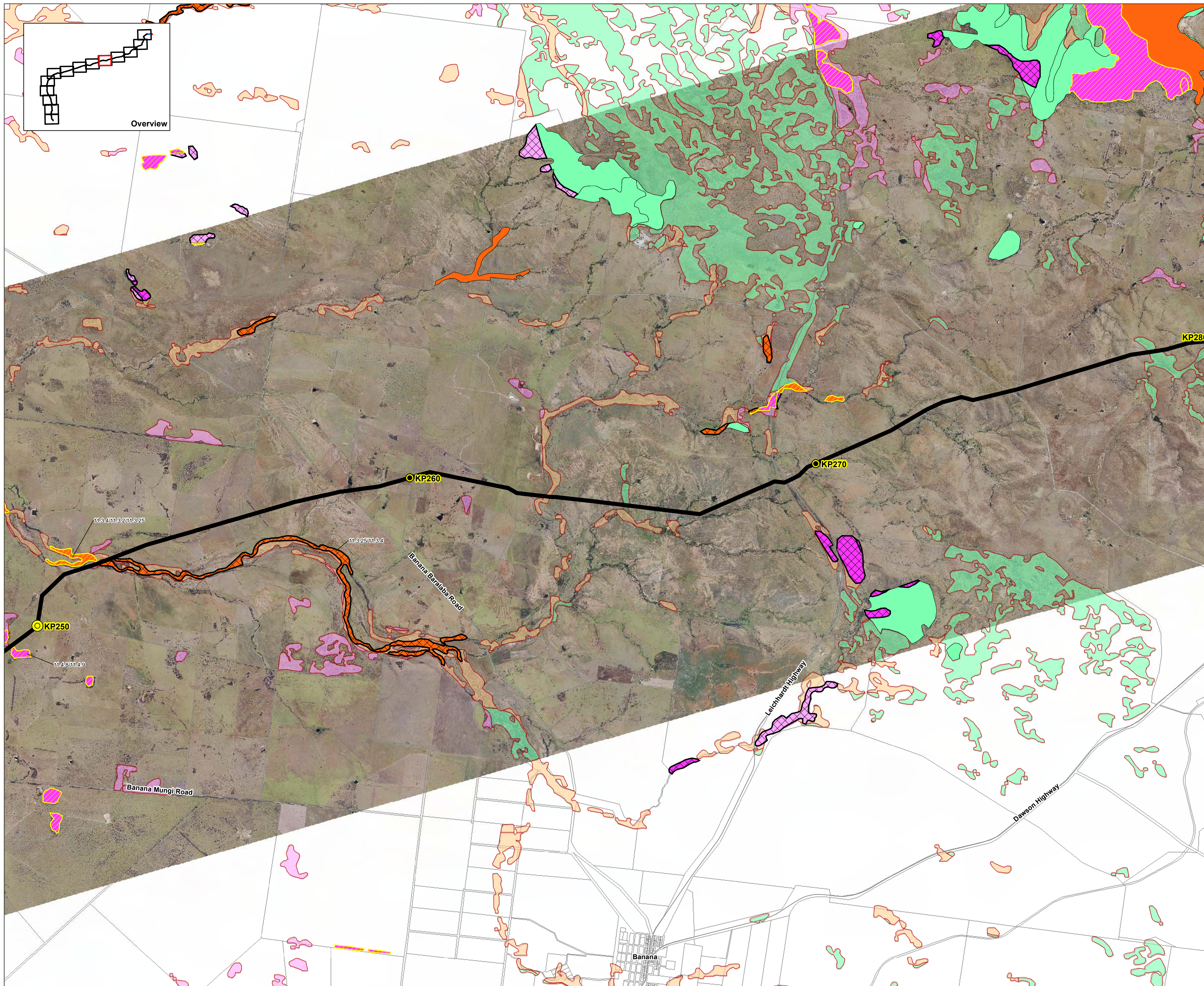
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Regional Ecosystems, High Value Regrowth Vegetation and Essential Habitats

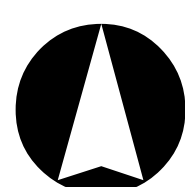
Figure 9.2 (Page 10 of 14)

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Map by: BS



A1 scale: 1:50,000
 0 1,000 2,000 3,000 4,000 5,000m

GLNG No: 3381-40-0424
 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

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High Value Regrowth Vegetation

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- Essential Regrowth Habitat

EVNT Threatened Species

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- Apatophyllum teretifolium*
- Bertya opposens*
- Cycas megacarpa*
- Gonocarpus urceolatus*
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- Melaleuca irbyana*
- Solanum johnsonianum*

- Bioregions

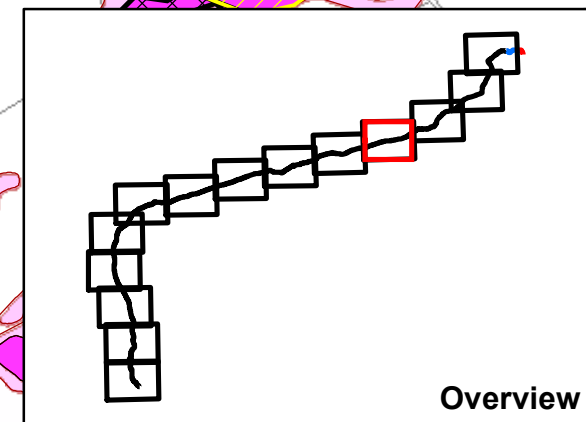
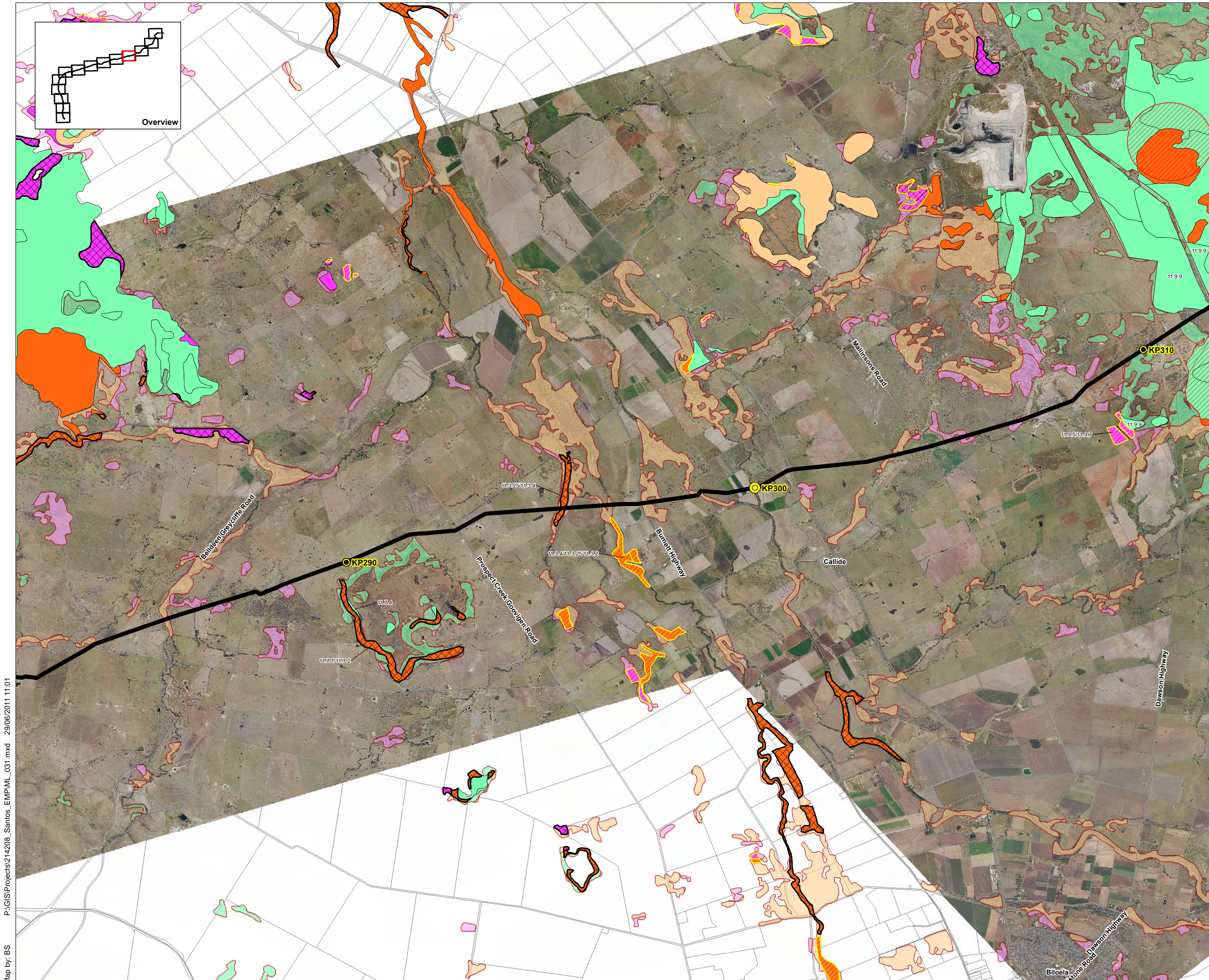
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 High Value Regrowth Vegetation: Version 2, The State of Queensland (Department of Environment and Resource Management), Nov 2009.
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 Threatened Species: Aurecon Field Data, 2010.
 Bioregions: Version 5, Department of Environment and Resource Management, Feb 2011.

Regional Ecosystems, High Value Regrowth Vegetation and Essential Habitats

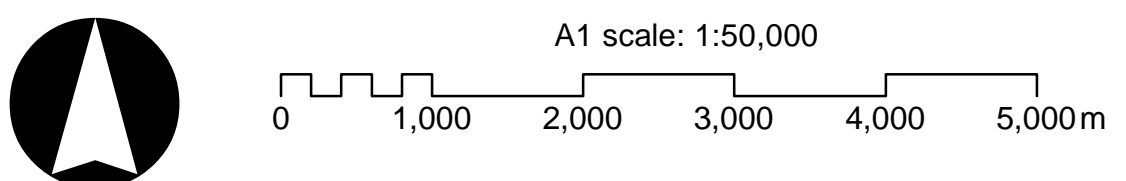
Figure 9.2 (Page 11 of 14)

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 Map by: BS



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High Value Regrowth Vegetation

- Endangered Regional Ecosystem
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- Least Concern Regional Ecosystem

- Regional Ecosystem where VM and BD status differ

- EPBC Threatened Species/ Ecological Community

- Essential Habitat

- Essential Regrowth Habitat

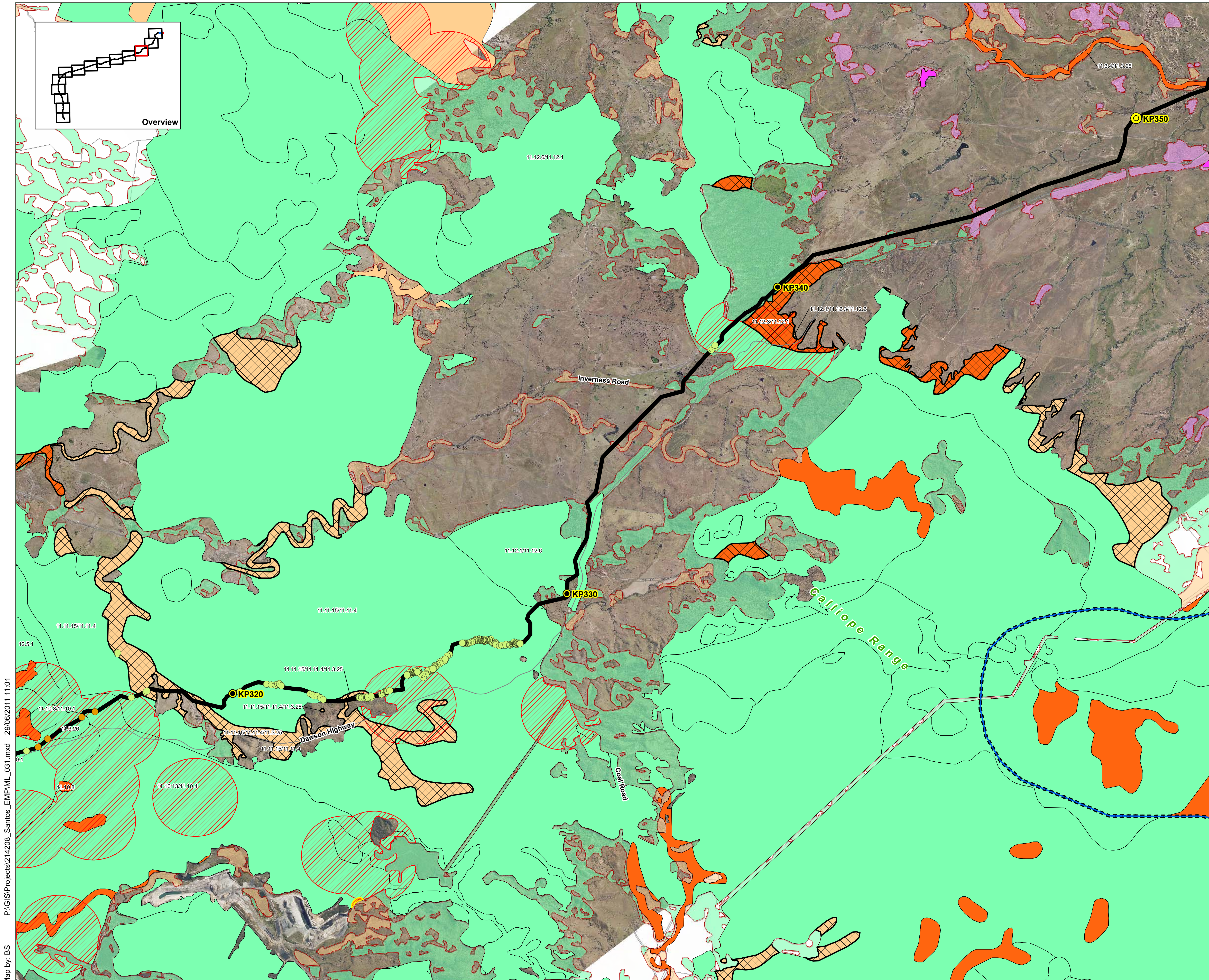
EVNT Threatened Species

- Acacia gittinsii*
- Acacia pedleyi*
- Acacia pubicosta*
- Acacia spania*
- Apatophyllym teretifolium*
- Bertya opposens*
- Cycas megacarpa*
- Gonocarpus urceolatus*
- Homoranthus decasetus*
- Melaleuca irbyana*
- Solanum johnsonianum*

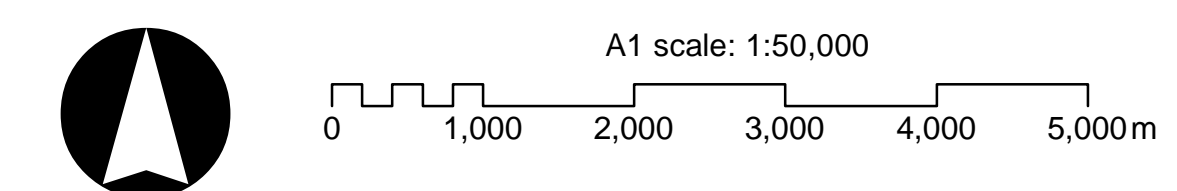
- Bioregions

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Regional Ecosystems, High Value Regrowth Vegetation and Essential Habitats
Figure 9.2 (Page 12 of 14)



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Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

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Kilometre Post Distance Marker

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High Value Regrowth Vegetation

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Regional Ecosystem where VM and BD status differ

- EPBC Threatened Species/ Ecological Community

Essential Habitat

- Essential Regrowth Habitat

EVNT Threatened Species

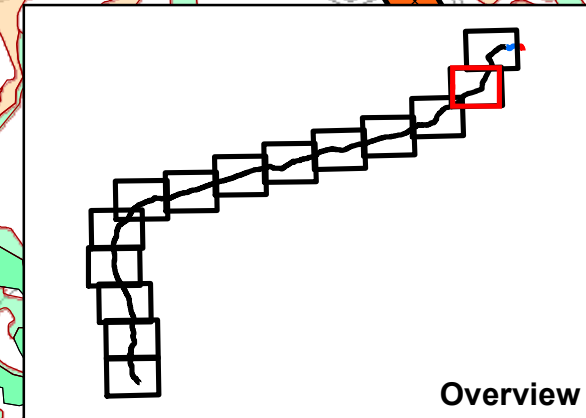
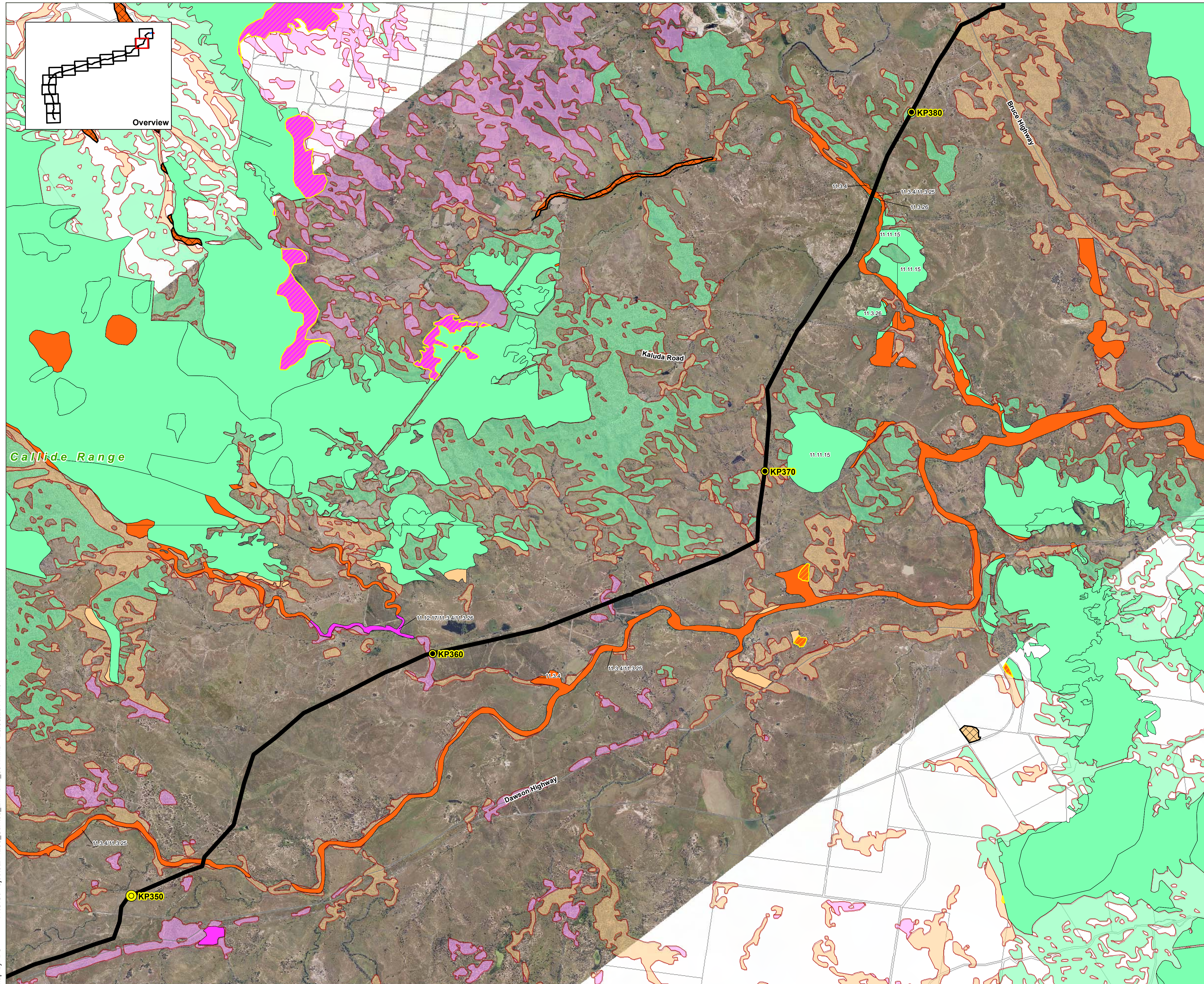
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- Solanum johnsonianum*

Bioregions

Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Regional Ecosystems: Version 6, The State of Queensland (Department of Environment and Resource Management), Nov 2009.
 High Value Regrowth Vegetation: Version 2, The State of Queensland (Department of Environment and Resource Management), Nov 2009.
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 Threatened Species: Aurecon Field Data, 2010.
 Bioregions: Version 5, Department of Environment and Resource Management, Feb 2011.

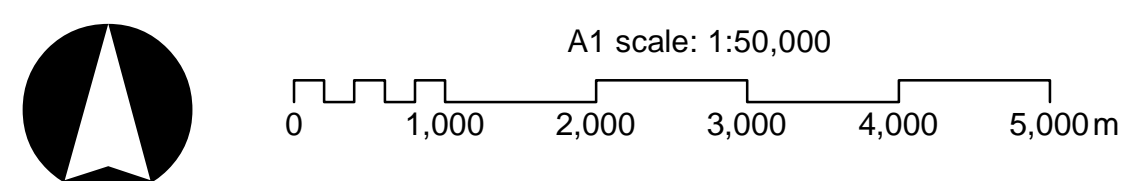
Regional Ecosystems, High Value Regrowth Vegetation and Essential Habitats Figure 9.2 (Page 13 of 14)

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Overview

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Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
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Kilometre Post Distance Marker

- 50km
- 10km

Regional Ecosystem - Biodiversity Status

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High Value Regrowth Vegetation

- Endangered Regional Ecosystem
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Regional Ecosystem where VM and BD status differ

EPBC Threatened Species/ Ecological Community

Essential Habitat

Essential Regrowth Habitat

EVNT Threatened Species

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- Acacia pedleyi*
- Acacia pubicosta*
- Acacia spania*
- Apatophyllum teretifolium*
- Bertya opposens*
- Cycas megacarpa*
- Gonocarpus urceolatus*
- Homoranthus decasetus*
- Melaleuca irbyana*
- Solanum johnsonianum*

Bioregions

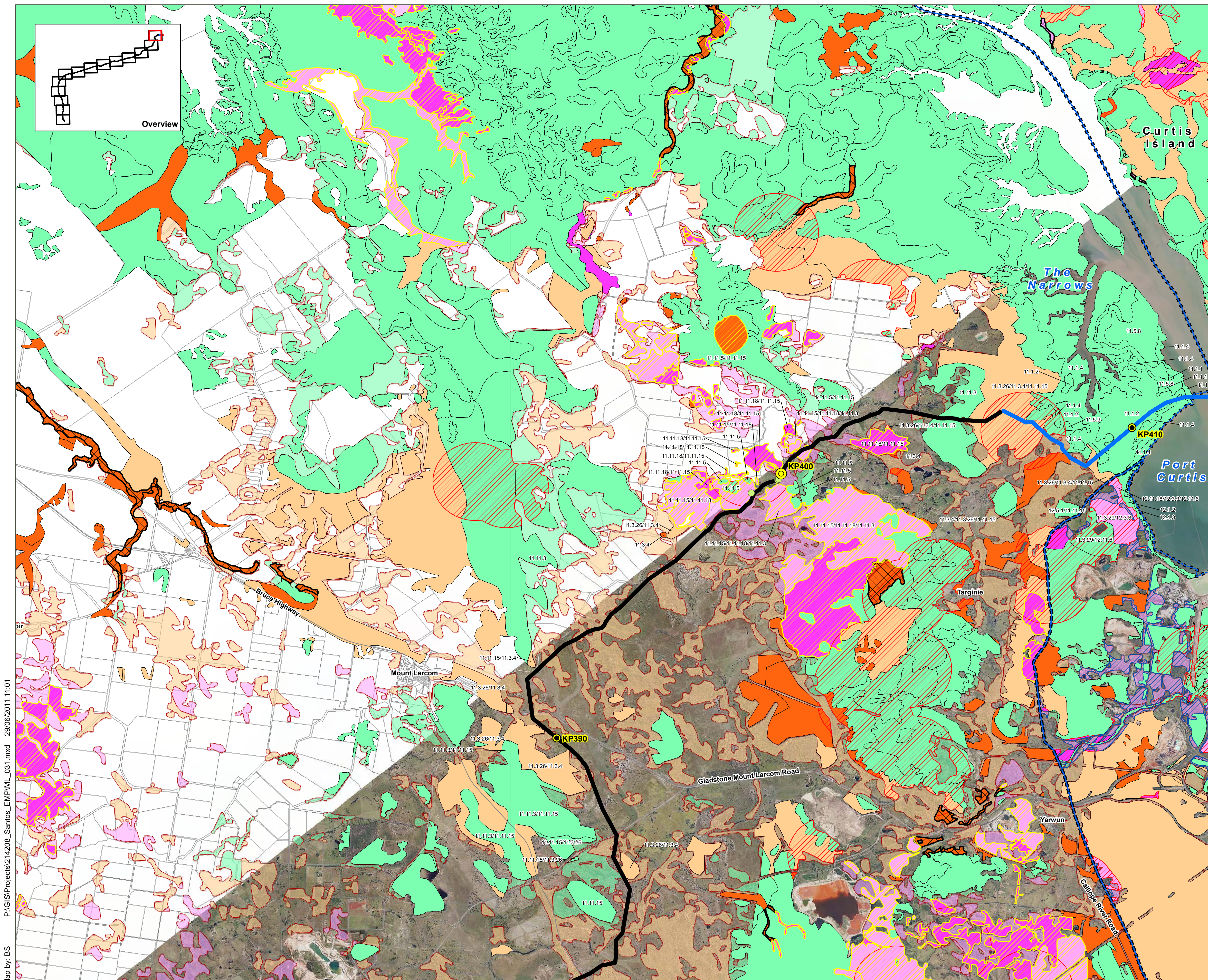
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 High Value Regrowth Vegetation: Version 2, The State of Queensland (Department of Environment and Resource Management), Nov 2009.
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 Threatened Species: Aurecon Field Data, 2010.
 Bioregions: Version 5, Department of Environment and Resource Management, Feb 2011.

Regional Ecosystems, High Value Regrowth Vegetation and Essential Habitats

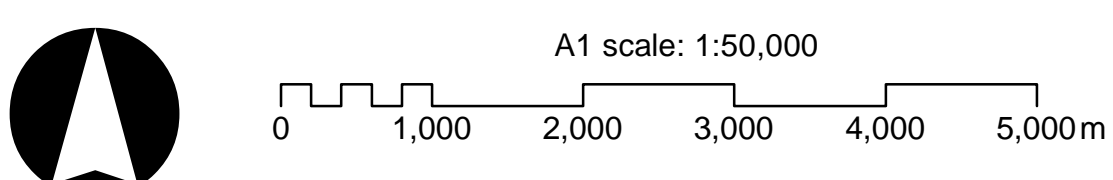
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Map by: BS



GLNG No: 3381-40-0424
Coordinate system: GCS GDA 1994

- Don River State Forest
- Mount Larcom State Forest
- Mount Stowe State Forest
- Scrubby Mountain State Forest
- Rundle State Forest
- Rundle Range Resource Reserve

Referable wetlands

As discussed in Chapter 1, a wetland shown on the Map of Referable Wetlands is considered a category C ESA. A map of referable wetlands illustrates the presence of wetland management areas (WMAs) and wetland protection area (WPA) triggers (ie 100 m buffers) within the Mainland GTP RoW (refer Chapter 14). These wetlands are typically associated with ephemeral watercourses within or adjacent to the RoW.

9.3.3 Flora

Regional Ecosystems

Thirty-three (33) REs are mapped within the Mainland GTP RoW, as outlined in Table 9.5. As illustrated in Figure 9.2, 'heterogeneous' RE polygons (RE polygons composed of two or more RE types) are mapped at several locations along the RoW (eg RE11.10.1/RE11.9.5a, RE11.3.2/RE11.3.25 etc).

Twelve (12) REs recorded within the Mainland GTP RoW are identified as having either Of Concern or Endangered Biodiversity Status. As discussed in Chapter 1, an RE community with a Biodiversity Status of Endangered or Of Concern constitutes a category B or C ESA, respectively.

EPBC Act Threatened Ecological Communities

Eight (8) of the RE communities present within or adjacent to the Mainland GTP RoW are considered analogous to an EPBC Act Threatened Ecological Community (refer Table 9.5).



Table 9.5 Regional Ecosystems mapped within the Mainland GTP RoW

RE	Community descriptions from REDD	Analogous Community as listed under the Provisions of the EPBC Act	Biodiversity status	VM Act status	EPBC Act threatened ecological community	ESA category	Area (ha) within RoW
11.3.1	<i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> open forest on alluvial plains	Brigalow (<i>Acacia harpophylla</i>) dominant and Co-dominant Communities	Endangered	Endangered	Endangered	B	0.02
11.3.2*	<i>Eucalyptus populnea</i> woodland on alluvial plains*	Weeping Myall Woodland	Of concern	Of concern	Endangered	C	6.62
11.3.3	<i>Eucalyptus coolabah</i> woodland on alluvial plains	N/A	Of concern	Of concern	N/A	C	0.43
11.3.4	<i>Eucalyptus tereticornis</i> and/or <i>Eucalyptus spp.</i> tall woodland on alluvial plains	N/A	Of concern	Of concern	N/A	C	4.00
11.3.17	<i>Eucalyptus populnea</i> woodland with <i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> on alluvial plains	N/A	Endangered	Of concern	N/A	B	7.55
11.3.25	<i>Eucalyptus tereticornis</i> or <i>E. camaldulensis</i> woodland fringing drainage lines	N/A	Of concern	Least concern	N/A	C	3.54
11.3.26	<i>Eucalyptus moluccana</i> or <i>E. microcarpa</i> woodland to open forest on margins of alluvial plains	N/A	No concern at present	Least concern	N/A	N/A	5.76
11.3.39	<i>Eucalyptus melanophloia</i> +/- <i>E. chloroclada</i> woodland on undulating plains and valleys with sandy soils	N/A	No concern at present	Least concern	N/A	N/A	0.08
11.4.8	<i>Eucalyptus cambageana</i> woodland to open forest with <i>Acacia harpophylla</i> or <i>A. argyrodendron</i> on Cainozoic clay plains	Brigalow (<i>Acacia harpophylla</i>) dominant and Co-dominant Communities	Endangered	Endangered	Endangered	B	0.13
11.4.9a	<i>Acacia harpophylla</i> , <i>Lysiphyllum carronii</i> +/- <i>Casuarina cristata</i> open-forest to woodland	Brigalow (<i>Acacia harpophylla</i>) dominant and Co-dominant Communities	Endangered	Endangered	Endangered	B	0.17
11.5.2	<i>Eucalyptus crebra</i> , <i>Corymbia spp.</i> , with <i>E. moluccana</i> on lower slopes of Cainozoic sand plains/remnant surfaces	N/A	No concern at present	Least concern	N/A	N/A	12.72
11.5.2a	<i>Allocasuarina luehmannii</i> low tree layer with or without emergent woodland.	N/A	No concern at present	Least concern	N/A	N/A	0.60





RE	Community descriptions from REDD	Analogous Community as listed under the Provisions of the EPBC Act	Biodiversity status	VM Act status	EPBC Act threatened ecological community	ESA category	Area (ha) within RoW
11.5.5c	<i>Eucalyptus melanophloia</i> , and/or <i>Eucalyptus populnea</i> +/- <i>Callitris glaucophylla</i> +/- <i>Allocasuarina luehmannii</i> sometimes <i>E. conica</i> is present in the overstorey	N/A	No concern at present	Least concern	N/A	N/A	2.83
11.8.4	<i>Eucalyptus melanophloia</i> woodland on Cainozoic igneous rocks. Hillsides	N/A	No concern at present	Least concern	N/A	N/A	8.14
11.9.1	<i>Acacia harpophylla</i> - <i>Eucalyptus cambageana</i> open forest to woodland on fine-grained sedimentary rocks	Brigalow (<i>Acacia harpophylla</i>) dominant and Co-dominant Communities	Endangered	Endangered	Endangered	B	0.19
11.9.5	<i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> open forest on fine-grained sedimentary rocks	Brigalow (<i>Acacia harpophylla</i>) dominant and Co-dominant Communities	Endangered	Endangered	Endangered	B	2.87





RE	Community descriptions from REDD	Analogous Community as listed under the Provisions of the EPBC Act	Biodiversity status	VM Act status	EPBC Act threatened ecological community	ESA category	Area (ha) within RoW
11.9.5a	<i>Acacia harpophylla</i> predominates and forms a fairly continuous canopy (10-18m high). Other tree species such as <i>Eucalyptus populnea</i> , <i>Casuarina cristata</i> , <i>Cadellia pentastylis</i> and <i>Brachychiton spp.</i> may also be present in some areas and form part of the canopy or emerge above it. Scattered <i>Eucalyptus orgadophila</i> may occur, especially on upper slopes and crests. A dense tall shrub layer dominated by a range of species is usually present, while a more open low shrub layer often occurs. Common species in these layers include <i>Croton insularis</i> , <i>Denhamia oleaster</i> , <i>Apophyllum anomalum</i> , <i>Croton phebalioides</i> , <i>Alectryon diversifolius</i> and <i>Carissa ovata</i> . The ground layer is sparse, most frequently composed of <i>Ancistrachne uncinulata</i> and <i>Eragrostis megalosperma</i> and varies with the density of the shrub layers. Occurs on undulating plains and rises formed mainly on shales. The soils are predominantly cracking clay soils, which are strongly alkaline at or near the surface and acidic beneath, or dark brown and grey-brown gradational soils, with a coarse-textured surface grading into an alkaline, clayey subsoil	Brigalow (<i>Acacia harpophylla</i>) dominant and Co-dominant Communities	Endangered	Endangered	Endangered	B	3.06
11.9.9	<i>Eucalyptus crebra</i> woodland on fine-grained sedimentary rocks	N/A	No concern at present	Least concern	N/A	N/A	1.26
11.10.1	<i>Corymbia citriodora</i> open forest on coarse-grained sedimentary rocks	N/A	No concern at present	Least concern	N/A	N/A	49.54
11.10.3	<i>Acacia catenulata</i> or <i>A. shirleyi</i> open forest on coarse-grained sedimentary rocks. Crests and scarps	N/A	No concern at present	Least concern	N/A	N/A	5.71





RE	Community descriptions from REDD	Analogous Community as listed under the Provisions of the EPBC Act	Biodiversity status	VM Act status	EPBC Act threatened ecological community	ESA category	Area (ha) within RoW
11.10.4	<i>Eucalyptus decorticans</i> , <i>Lysicarpus angustifolius</i> +/- <i>Eucalyptus</i> spp., <i>Corymbia</i> spp., <i>Acacia</i> spp. woodland on coarse-grained sedimentary rocks. Crests and scarps	N/A	No concern at present	Least concern	N/A	N/A	0.14
11.10.7	<i>Eucalyptus crebra</i> woodland on coarse-grained sedimentary rocks	N/A	No concern at present	Least concern	N/A	N/A	3.7
11.10.7a	<i>Eucalyptus crebra</i> +/- <i>Callitris glaucophylla</i> +/- <i>Angophora leiocarpa</i> +/- <i>Eucalyptus</i> spp. woodland. <i>Eucalyptus crebra</i> predominates and forms a distinct but discontinuous canopy (16-20 m high). In places, <i>Angophora leiocarpa</i> forms part of the canopy. The low tree layer (12-16 m high) is dominated by <i>Callitris glaucophylla</i> . Scattered tall and low shrubs may be present. The ground layer is open to dense, and dominated by perennial grasses, usually <i>Aristida</i> spp. or <i>Themeda triandra</i>	N/A	No concern at present	Least concern	N/A	N/A	1.85
11.10.13	<i>Eucalyptus</i> spp. and/or <i>Corymbia</i> spp. open forest on scarps and sandstone tablelands	N/A	No concern at present	Least concern	N/A	N/A	11.39
11.10.13a	<i>Eucalyptus cloeziana</i> +/- <i>E. melanoleuca</i> +/- <i>Corymbia bunites</i> +/- <i>E. sphaerocarpa</i> woodland to open-forest	N/A	No concern at present	Least concern	N/A	N/A	30.15
11.11.3	<i>Corymbia citriodora</i> , <i>Eucalyptus crebra</i> , <i>E. acmenoides</i> open forest on old sedimentary rocks with varying degrees of metamorphism and folding. Coastal ranges	N/A	No concern at present	Least concern	N/A	N/A	2.20
11.11.4	<i>Eucalyptus crebra</i> woodland on old sedimentary rocks with varying degrees of metamorphism and folding. Coastal ranges	N/A	No concern at present	Least concern	N/A	N/A	2.34



RE	Community descriptions from REDD	Analogous Community as listed under the Provisions of the EPBC Act	Biodiversity status	VM Act status	EPBC Act threatened ecological community	ESA category	Area (ha) within RoW
11.11.4a	<i>Eucalyptus tereticornis</i> dominated woodland. Other tree species listed above may occur as sub or co-dominant species	N/A	No concern at present	Least concern	N/A	N/A	0.45
11.11.15	<i>Eucalyptus crebra</i> woodland on deformed and metamorphosed sediments and interbedded volcanics. Undulating plains	N/A	No concern at present	Least concern	N/A	N/A	34.92
11.11.15a	<i>Eucalyptus crebra</i> , <i>E. exserta</i> woodland	N/A	No concern at present	Least concern	N/A	N/A	0.27
11.11.18	Semi-evergreen vine thicket on old sedimentary rocks with varying degrees of metamorphism and folding. Lowlands	Semi-Evergreen Vine Thicket of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered	Endangered	Endangered	B	0.50
11.12.1	<i>Eucalyptus crebra</i> woodland on igneous rocks	N/A	No concern at present	Least concern	N/A	N/A	7.94
11.12.6	<i>Corymbia citriodora</i> open forest on igneous rocks (granite)	N/A	No concern at present	Least concern	N/A	N/A	2.23

Table notes RE11.3.2 is analogous to the Weeping Myall Community ONLY if it contains Weeping Myall (*Acacia pendula*) as densities and heights as specified by the provisions of the EPBC Act. This can only be determined by ground-truthing

Source REDD database (version 6.0b), 2011



It is important to note that EPBC Act threatened ecological communities may also occur as regrowth communities (eg Brigalow regrowth that retains the species composition and structural elements typical of that found in the undisturbed listed regional ecosystems is considered to be part of the listed Brigalow ecological community (Environment Australia 2001)). Thus it is imperative that ground-truthing of the entire RoW is conducted in order to identify such communities.

Ground-truthing within selected areas of the RoW has confirmed that RE mapping (as illustrated in Figure 9.2) is generally accurate (URS 2008). However, ground-truthing of the entire Mainland GTP RoW is necessary in order to verify the DERM mapped RE polygons.

The proponent will carry out ground-truthing.

Based on the DERM RE mapping, the most common RE within the RoW is RE11.10.1 (ie *Corymbia citriodora* open forest on coarse-grained sedimentary rocks). This RE occupies approximately 49.54 ha of the Mainland GTP RoW. RE11.10.1 was verified during EIS flora surveys within several areas of the range crossings. This RE is characterised by a tall canopy of *Corymbia citriodora* subsp. *citriodora* (Spotted gum). Sub-dominant canopy species included Narrow-leaved ironbark (*Eucalyptus crebra*) and *Corymbia trachyphloia* (Brown bloodwood). The shrub layer supports a number of species including *Alphotonia excelsa* (Red ash), *Acacia leiocalyx* (Black wattle), and *Cassinia laevis* (Cough bush). Ground cover species included *Cymbopogon refractus* (Barbed-wire grass), *Heteropogon contortus* (Black speargrass) and *Lantana montevidensis* (Creeping lantana).

The second most common RE within the Mainland GTP RoW is RE11.11.15 (ie *Eucalyptus crebra* woodland on metamorphics). This RE is mapped as occupying approximately 34.92 ha of the Mainland GTP RoW, and was verified during EIS flora surveys along several of the range crossings. It supports a canopy dominated by Narrow-leaved ironbark with sub-dominant species including *Corymbia erythrophloia* (Gum-topped bloodwood). The shrub layer is considered sparse and includes Red Ash, *Acacia disparrima* (Hickory wattle) and *Acacia decora* (Pretty wattle). The ground cover supports a diversity of grass and herb species including Barbed-wire grass, Black speargrass and *Cyanthillium cinereum* (Vernonia).

The majority of the major creek crossings along the Mainland GTP RoW support RE11.3.25. This community is characterised by a tall canopy of *Eucalyptus tereticornis* (Queensland blue gum). The mid-storey and shrub layers often supported *Casuarina cunninghamiana* (River sheoak), *Melaleuca bracteata* (Black tea-tree), *Melaleuca linariifolia* (Snow-in-summer) and *Callistemon viminalis* (Weeping bottlebrush).

The Coolibah-Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions is also present within the GTP RoW.

However quaternary surveys indicate the presence of this community along the GTP RoW within a location incorrectly mapped as 11.5.5. Pre-clearance surveys will aim to identify any additional locations where mapping inconsistencies occur and report them accordingly. During the survey period, the boundaries of any located communities will also be delineated where possible.

As per the CG Report, high value regrowth vegetation (HVRV) containing Least Concern, Of Concern, and Endangered REs have been considered. Under the provisions of the VM Act, HVRV has been mapped within the Mainland GTP RoW. Ground-truthing within selected areas of the RoW and examination of aerials have confirmed that HVRV mapping (as illustrated in Figure 9.2) is generally accurate. However, ground-truthing of the entire RoW will be required in order to identify any mapping inaccuracies.

A species list of flora identified during previous surveys of the Mainland GTP RoW is provided in Table 9.7

Conservation significant flora species

A review of environmental databases identified 39 flora species, listed as having conservation significance (ie listed as Endangered, Vulnerable or Near Threatened) under the provisions of the EPBC Act and/or the NC Act, as potentially occurring within a 5 km radius of the Mainland GTP RoW (Table 9.6).

The likelihood of their occurrence within the Mainland GTP RoW has been assessed and given a rating, as follows:

- “Known” - indicates that the species has been recorded during field investigations; a species record occurs (ie HERBRECS) within close proximity; or discussions with land holders have indicated that this species occurs within the area
- “High” - indicates that good quality, suitable, habitat occurs within and/or adjacent to the RoW
- “Moderate” - indicates that potentially suitable habitat occurs within and/or adjacent to the RoW, but is considered very small or exists in a degraded state
- “Low” - indicates that suitable habitat does not occur within and/or adjacent to the RoW. This rating may also indicate that the site is outside of the recognised geographic range of the species



Table 9.6 Likelihood of significant flora species occurring within the vicinity of the Mainland GTP RoW

Scientific name	Common name	NC Act status	EPBC Act status	Habitat	Likelihood of occurrence
<i>Acacia gittinsii</i>	Gittins wattle	NT	-	This species is endemic to Central Queensland (generally extending from north of Taroom to the Blackdown Tablelands). Available information suggests this species is usually observed on sandstone derived soils in eucalypt woodlands, often as dense stands (DNR 1999)	This species is known to occur within the Mainland GTP RoW (Ecologica Consulting, 2010)
<i>Acacia pedleyi</i>	Pedley's wattle	V	-	This species is restricted to the Callide and Calliope Ranges in Central Qld and has been observed on alluvial flats, hill slopes and ridges lines in alluvial loams to red clayey loams derived from sandstone, granitic and basalt rocks. This species occurs in a variety of woodland/open forest sclerophyll communities and recently disturbed edge environments	This species is known to occur within the Mainland GTP RoW in association with the Callide Timber Reserve (Ecologica Consulting, 2010)
<i>Acacia pubicosta</i>	-	NT	-	Based on Maslin (2001), this species is considered to be restricted to the Biggenden area in SEQ on rocky slopes. Specimens from the Blackland Tableland, Mt Morgan and Callide Valley are now considered to be <i>A. polifolia</i> . However, there is essential habitat for <i>A. pubicosta</i> within the Callide Timber Reserve	This species is known to occur within the Mainland GTP RoW (Ecologica Consulting, 2010). Essential Habitat is mapped for this species within the RoW
<i>Acacia spania</i>	-	NT	-	Species habitat information is extremely limited with observation made in Maslin (2001) recording the species as restricted to the emerald area in open sclerophyll woodlands on shallow red soils. However, this species has now been recorded from the Fairview gas fields north of Injune and the Expedition Range	This species is known to occur within the Mainland GTP RoW (Ecologica Consulting, 2010)
<i>Acacia tingoorensis</i>	-	V	-	<i>Acacia tingoorensis</i> is found near Kingaroy, in the Burnett district of southeastern Queensland. It is also known from the Ingham area in north-eastern Queensland. (Maslin <i>et al</i> 2001; Herbrechs 2008). It grows in eucalypt woodland or forest, on deep red loam, shallow loamy or sandy soils. (Maslin <i>et al</i> 2001)	Low likelihood of occurrence within the RoW. This species was not detected during targeted searches (Ecologica Consulting, 2010). No Queensland Herbarium records for this species occur within close proximity to the RoW



Scientific name	Common name	NC Act status	EPBC Act status	Habitat	Likelihood of occurrence
<i>Apatophyllum teretifolium</i>	-	NT	-	<p><i>Apatophyllum teretifolium</i> occurs on sandstone derived soils amongst rocky outcrops or along cliff lines. It occurs in association with a variety of eucalypt, tea-tree, Cypress pine and acacia woodland/forest communities</p> <p>This species is known to occur as far south as Barakula SF and appears to be present within scattered populations throughout the Fairview gas fields, and the Canarvon and Expedition Ranges</p>	This species is known to occur within the Mainland GTP RoW (Ecologica Consulting, 2010). Essential Habitat is mapped for this species within the RoW
<i>Bertya opposens</i>	-	LC	V	<p>Old habitat information for this species is limited. However, <i>Bertya opposens</i> is generally observed on cliff edges and low rises and may occur in a number of different habitats, including stoney mallee ridges and cypress forests. Within the GTP corridor, this species has been observed at the base of cliffs against sandstone boulders (NPWS 2002)</p>	This species is known to occur within RE11.10.3/11.3.25 of the Mainland GTP RoW (Ecologica Consulting, 2010)
<i>Bosistoa transversa</i> (<i>Bosistoa selwynii</i>)	Three-leaved Bosistoa	-	V	Lowland sub-tropical rainforests up to 300 m	Low likelihood of occurrence within the Mainland GTP RoW due to absence of suitable habitat. This species was not detected during targeted searches (Ecologica Consulting, 2010). No Queensland Herbarium records for this species occur within close proximity to the RoW
<i>Bulbophyllum globuliforme</i>	Miniature Moss-orchid	NT	V	Tiny epiphytic orchid only occurring in extensive masses on trees on trunks and branches of Hoop Pine (<i>Araucacria cunninghamii</i>). Typically occurs in tall Aracarian rainforest above 500 m in altitude, but has been found in rainforests of the coastal lowlands	Low likelihood to occur within the Mainland GTP RoW due to absence of suitable habitat. This species was not detected during targeted searches (Ecologica Consulting, 2010). No Queensland Herbarium records for this species occur within close proximity to the RoW





Scientific name	Common name	NC Act status	EPBC Act status	Habitat	Likelihood of occurrence
<i>Cadellia pentastylis</i>	Ooline	V	V	Ooline is usually associated with <i>Acacia harpophylla</i> (Brigalow), <i>Casuarina cristata</i> (Belah), <i>Acacia catenulata</i> (Bendee) and <i>Lysiphyllum carronii</i> (Red bauhinia) species in dry rainforest, vine thicket and sclerophyll communities on clay plains, sandstone slopes and ridgelines. <i>N.B. Ooline may be observed as the locally dominant species within these communities</i>	High likelihood that this species may occur within the Mainland GTP RoW. However, targeted searches within the actual RoW have not resulted in the detection of this species (Ecologica Consulting, 2010). Queensland Herbarium records for this species occur within the locale (accuracy of data 1600 m)
<i>Cerbera dumicola</i>	-	NT	-	Occurs within mixed Eucalypt woodland to forest communities. Is known within the Biloela region	Low to Moderate likelihood that this species occurs within the Mainland GTP RoW. Targeted searches have not resulted in detection of this species within the RoW. This species has been recorded to the east and north-east of Biloela (within 10 km from the Mainland GTP RoW) (QCLNG, 2009)
<i>Commersonia argentea</i>	-	-	V	Known to be widespread from Injune and west along the Great Dividing Range towards Tambo in central Queensland. It has been recorded in Carnarvon National Park (Queensland Herbarium, 2008). This species occurs within the Burnett Mary, South West (Queensland) and Fitzroy Natural Resource Management Regions (DSEWPC, 2010)	Low likelihood that this species occurs within the Mainland GTP RoW. Targeted searches within the Mainland GTP RoW have not resulted in the detection of this species (Ecologica Consulting, 2010). No Queensland Herbarium records for this species occur within close proximity to the RoW
<i>Cossinia australiana</i>	Cossinia	E	E	Tall to very tall subtropical rainforest in association with hoop pine or coastal (littoral) rainforest on steep dune slopes, usually within 1 km of coastline	Low likelihood of presence within the Mainland GTP RoW due to absence of suitable habitat. This species was not detected during targeted searches (Ecologica Consulting, 2010). No Queensland Herbarium records for this species occur within close proximity to the RoW





Scientific name	Common name	NC Act status	EPBC Act status	Habitat	Likelihood of occurrence
<i>Cupaniopsis shirleyana</i>	Wedge-leaf tuckeroo	V	V	Known to occur within a variety of rainforest types on hillslopes, mountain tops, rocky headlands and creek banks	Low likelihood that this species occurs within the Mainland GTP RoW. Targeted searches have not resulted in the detection of this species within the RoW (Ecologica 2010). No Queensland Herbarium records for this species occur within close proximity to the RoW
<i>Cycas megacarpa</i>	Large-fruited zamia palm	E	E	Usually inhabits sclerophyll dominated grassy woodlands/open woodlands on rocky substrates (usually granite based). In the Calliope and Callide Ranges, this species is also commonly observed along drainage lines and dry creek beds beneath a dry rainforest canopy	This species is known to occur within the Mainland GTP RoW, in association with the Callide Timber Reserve (KP 314.5 – 329.25), and the remnant and regrowth vegetation along the Dawson Highway (KP 338.25, and KP 399 - 400) (Ecologica Consulting, 2010)
<i>Cycas ophiolitica</i>	Marlborough blue zamia palm	E	E	Typically associated with <i>Corymbia</i> woodlands on serpentinite substrates, mudstone and alluvial loams to 80-400 mm altitude in the Marlborough – Rockhampton region of central-eastern Queensland	Low likelihood to occur within the Mainland GTP RoW due to absence of suitable habitat and the RoW being outside of its distribution. This species was not detected during targeted searches (Ecologica Consulting, 2010). No Queensland Herbarium records for this species occur within close proximity to the RoW
<i>Dichanthium queenslandicum</i>	King Blue-grass	V	V	Endemic to Queensland where it often occurs on black clay soils that support Bluegrass communities	Moderate likelihood that this species occurs within the Mainland GTP RoW due to the presence of potentially suitable habitat. Queensland herbarium record for this species within the locale (accuracy of data 1600 m). Targeted searches for this species within the RoW have not resulted in its detection (Ecologica Consulting, 2010)





Scientific name	Common name	NC Act status	EPBC Act status	Habitat	Likelihood of occurrence
<i>Digitaria porrecta</i>	Finger Panic Grass	NT	E	<i>Digitaria porrecta</i> is a perennial tussock-forming grass that can vegetatively reproduce. It occurs within native grassland, woodlands or open forest with a grassy understorey, on richer soils. This species is often found along roadsides and travelling stock routes where there is light grazing and occasional fire (NSW Gov, 2005)	Moderate likelihood that this species may occur within the Mainland GTP RoW. However, targeted searches within the Mainland GTP RoW have not resulted in the detection of this species (Ecologica Consulting, 2010)
<i>Desmodium macrocarpum</i>	Large-podded Tick-trefoil	NT	-	Restricted to region between Forty Mile Scrub near Mount Garnet and Mundubbera in coastal eastern Queensland. Found in open forests and woodlands with sparse shrubby understorey of Currant Bush (<i>Carissa ovata</i>) and Dysentery Bush (<i>Grewia retusifolia</i>) and semi-evergreen vine thickets in red earths, rarely sandy clay soils and at altitudes to 884 m	Moderate likelihood of occurrence within the Mainland GTP RoW. Targeted searches have not resulted in the detection of this species (Ecologica Consulting, 2010). Queensland Herbarium records for this species occur within 1 km of the RoW (accuracy of data 100 m)
<i>Eucalyptus decolor</i>	-	NT	-	This species is endemic to south-eastern Queensland. It is known only from two disjunct occurrences, namely the Many Peaks Range, south of Gladstone, and ranges south of Biggenden	Low likelihood that this species occurs within the Mainland GTP RoW due to the absence of suitable habitat. The RoW is considered outside of this species' known distribution. Targeted searches did not result in the detection of this species (Ecologica 2010). No Queensland Herbarium records for this species occur within close proximity to the RoW
<i>Gonocarpus urceolatus</i>	Raspweed	V	-	Information is limited regarding habitat associations for this species with new populations being found outside of originally recorded distribution range over the past few years. However, based on observations made within the Fairview gas fields, this species has been observed within recently disturbed (fire, road, pipeline easement and quarry development) ironbark and cypress communities on sandstone derived soils. This species appears to be confined to margin environments and has not been observed further than 25 m from the edge environment	This species is known to occur within the Mainland GTP RoW (within the vicinity of KP 9.25 (Ecologica Consulting, 2010)





Scientific name	Common name	NC Act status	EPBC Act status	Habitat	Likelihood of occurrence
<i>Graptophyllum excelsum</i>	Letter leaf	NT	-	Typically found in dry vine thickets usually on soils derived from limestone	Low likelihood of occurrence within the Mainland GTP RoW due to absence of suitable habitat. This species was not detected during targeted searches (Ecologica Consulting, 2010). Queensland Herbarium records for this species occur within 500 m to the RoW (accuracy of data 100 m)
<i>Grevillea hockingsii</i>	-	V	-	Occurs in Queensland, where known from three disjunct areas: Coomingleh State Forest West of Monto, Callide Range East of Biloela, and Razor Back Range near Mt Morgan. Grows in shrubby understorey in eucalypt woodland or open forest, around rocky sandstone breakaways, occasionally on sandy flats or around soaks	Low* likelihood of occurrence within the Mainland GTP RoW due to absence of suitable habitat. This species was not detected during targeted searches (Ecologica Consulting, 2010). No Queensland Herbarium records for this species occur within close proximity to the RoW
<i>Hernandia bivalvis</i>	Cudgerie	NT	-	Dry rainforest and vine scrub	Low likelihood that this species occurs within the Mainland GTP RoW. Targeted searches for this species within the RoW have not resulted in its detection (Ecologica Consulting, 2010). Queensland Herbarium records for this species occur within 1 km of the RoW (accuracy of data 100 m)
<i>Homoranthus decasetus</i>	Red mouse bush	NT	-	Limited habitat information has been published for this species. However, based on field findings, this species occurs within sclerophyll communities (particularly ironbar) on sandstone and sandstone derived soils associated with creek lines, drainage slopes and lower to mid slopes above creek lines	This species is known to occur within the Mainland GTP RoW (Ecologica Consulting, 2010)





Scientific name	Common name	NC Act status	EPBC Act status	Habitat	Likelihood of occurrence
<i>Leucopogon cuspidatus</i>	-	-	V	Open forest, woodland and heath on rocky slopes with granitic or serpentinite substrates. The distribution of this species overlaps with the following EPBC Act listed threatened ecological communities: <ul style="list-style-type: none"> Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions Bluegrass (<i>Dichanthium spp.</i>) dominant grasslands of the Brigalow Belt Bioregions (North and South) Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant). (DSEWPC, 2010) 	Moderate likelihood that this species occurs within the Mainland GTP RoW. Targeted searches within the Mainland GTP RoW have not resulted in the detection of this species (Ecologica Consulting, 2010). Queensland Herbarium records for this species occur within Expedition Range, to the east of Rolleston (accuracy of data 1600 m)
<i>Leucopogon grandiflorus</i>	-	NT	-	This species is known to occur within the Expedition National Park (DERM, 2010)	Moderate likelihood to occur within the Mainland GTP RoW. This species was not detected during targeted searches (Ecologica Consulting, 2010). No Queensland Herbarium records for this species occur within close proximity to the RoW
<i>Macropteranthes fitzalanii</i>	-	NT	-	Usually found on rocky outcrops of coastal notophyll/microphyll vine forest and littoral rainforest communities between Rockhampton (north of) and Proserpine (north of)	Low likelihood that this species occurs within the Mainland GTP RoW. This species was not detected during targeted searches (Ecologica Consulting, 2010). No Queensland Herbarium records for this species occur within close proximity to the RoW
<i>Macropteranthes leiocaulis</i>	Southern bonewood	NT	-	Known to occur in association with RE11.4.1 (EPA, 2007). Deciduous vine thickets, semi-evergreen vine thickets and araucarian microphyll vine forests on red eucrozems or sandstone talus	Low likelihood that this species occurs within the Mainland GTP RoW due to the lack of suitable habitat. This species was not detected during targeted searches (Ecologica Consulting, 2010). Queensland Herbarium records for this species occur within 1 km of the RoW (accuracy of data 100 m)





Scientific name	Common name	NC Act status	EPBC Act status	Habitat	Likelihood of occurrence
<i>Melaleuca irbyana</i>	Bushhouse paperbark	E	-	<i>Melaleuca irbyana</i> has been observed in flat environments that are periodically waterlogged (poor draining) including tablelands on sandstone derived soils. This species is associated with sclerophyll woodlands/forests (particularly ironbark), mixed forest and <i>Melaleuca</i> woodland communities with a sparse understorey (DERM, 2009g)	This species is known to occur within the Mainland GTP RoW (Ecologica Consulting, 2010)
<i>Parsonsia larcomensis</i>	-	V	V	<i>Parsonsia larcomensis</i> occurs in the Rockhampton/ Mount Perry area of Queensland, where it is found in open heathland and shrubland at or near the summits of mountain peaks, in shallow loamy soils on cliffs or among outcrops of acid volcanic rocks and serpentites at 350 to 750 m above sea level (Williams, 1996). It has also been recorded from riverine rainforest habitat at one location (BRI collection details, n.d.)	Low likelihood that this species occurs within the Mainland GTP RoW. This species was not detected during targeted searches (Ecologica Consulting, 2010). No Queensland Herbarium records for this species occur within close proximity to the RoW
<i>Polianthion minutiflorum</i>	-	V	V	Grows in forest and woodland on sandstone slopes and gullies with skeletal soil, or deeper soils adjacent to deeply weathered laterite (Kellermann et al., 2006). Occurs in the Register of the National Estate-listed Callide Range Area (DEWHA, 2008)	Low likelihood that this species occurs within the Mainland GTP RoW. Targeted searches within the RoW have not resulted in the detection of this species (Ecologica Consulting, 2010). Queensland Herbarium records for this species occur within 1.3 km of the RoW (accuracy of data 1600 m)
<i>Pratia podenzanae</i>	-	NT	-		Low likelihood of occurrence within the Mainland GTP RoW. Targeted searches have not resulted in the detection of this species within the RoW (Ecologica Consulting, 2010). Queensland Herbarium records for this species occur within the locale (along Bindaree Road). The accuracy of this data point is 1600 m





Scientific name	Common name	NC Act status	EPBC Act status	Habitat	Likelihood of occurrence
<i>Quassia bidwillii</i>	Quassia	V	V	Occurs within lowland rainforests or rainforest margins and occasionally open forests, woodlands and mangroves in lithosols, skeletal soils, loamy sands and sandy soils to 1 to 617 m altitude in coastal regions	Low likelihood that this species occurs within the Mainland GTP RoW. Targeted searches within the RoW have not resulted in the detection of this species (Ecologica Consulting, 2010). Queensland Herbarium records for this species occur within Callide Range, approximately 1 km the RoW (accuracy of data 100 m)
<i>Solanum dissectum</i>	-	E	-	This species is known to occur in SEVT and Brigalow/Belah communities throughout the Leichhardt and Port Curtis pastoral districts (Bean, 2005). Regions dominated by this species is often listed as an Essential Habitat (EH)	High likelihood of occurrence within the RoW in association with <i>S. johnsonianum</i> (Ecologica Consulting, 2010). Queensland Herbarium records for this species occur within proximity to the RoW (accuracy of data 100 m)
<i>Solanum johnsonianum</i>	-	E	-	This species is known to occur in SEVT and Brigalow/Belah communities throughout the Leichhardt and Port Curtis pastoral districts (Bean, 2005)	This species is known to occur within the Mainland GTP RoW, (Ecologica Consulting, 2010). Queensland Herbarium records for this species occur within proximity to the RoW (accuracy of data 1600 m)
<i>Solanum elachophyllum</i>	-	E	-	This species is known to occur in SEVT and Brigalow/Belah communities throughout the Leichhardt and Port Curtis pastoral districts (Bean, 2005). Regions dominated by this species is often listed as EH	High likelihood of occurrence within the RoW in association with <i>S. johnsonianum</i> (Ecologica Consulting, 2010). Queensland Herbarium records for this species occur within proximity to the RoW (accuracy of data 100 m)
<i>Taeniophyllum muelleri</i>	Ribbon-root Orchid	-	V	Epiphyte on branches and branchlets of rainforest trees in coastal regions	Low likelihood of occurrence within the Mainland GTP RoW. This species was not detected during targeted searches (Ecologica Consulting, 2010). No Queensland Herbarium records for this species occur within close proximity to the RoW





Scientific name	Common name	NC Act status	EPBC Act status	Habitat	Likelihood of occurrence
<i>Tylophora linearis</i>	-	E	E	<i>Tylophora linearis</i> grows in dry scrub and open forest. Recorded from low-altitude sedimentary flats in dry woodlands of <i>Eucalyptus fibrosa</i> , <i>Eucalyptus sideroxylon</i> , <i>Eucalyptus albens</i> , <i>Callitris endlicheri</i> , <i>Callitris glaucophylla</i> and <i>Allocasuarina luehmannii</i> . It also grows in association with <i>Acacia hakeoides</i> , <i>Acacia lineata</i> , <i>Melaleuca uncinata</i> , <i>Myoporum</i> species and <i>Casuarina</i> species (NSW Gov, 2005)	Low likelihood of occurrence within the Mainland GTP RoW. This species was not detected during targeted searches (Ecologica Consulting, 2010). No Queensland Herbarium records for this species occur within close proximity to the RoW
<i>Wahlenbergia islensis</i>	-	NT	-	This species is known to occur in crevices of sandstone cliffs and slopes. The distribution range of this species continues to be extended with records now indicating that the species occurs in Isla and Robinson Gorges, Canarvon, Expedition and Chesteron Ranges and the Fairview gas fields (including Baffle Creek area)	This species is known to occur within the Mainland GTP RoW (Ecologica Consulting, 2010). Essential Habitat is mapped for this species within the RoW

Table Notes *Grevillea hockingsii* has been recorded within the SEIS as occurring within the vicinity of KP 401.25 (URS 2009). However, additional ecological surveys conducted by experienced flora ecologists within the Mainland GTP RoW have not resulted in the detection of this species. Thus due to the lack of Herbarium confirmation, it is considered that this species was previously incorrectly identified. Due to the absence of suitable habitat, this species is considered unlikely to occur within the Mainland GTP RoW.

Status T = Near Threatened; V = Vulnerable; E = Endangered; CE = Critically Endangered; EH = Essential Habitat.

NC Act = *Nature Conservation Act 1992*; EPBC Act = *Environment Protection Biodiversity Conservation Act 1999*.

Sources DERM Wildlife Online and EPBC Act Databases; Herbreccs data 2010.





Mainland GTP RoW floristic composition

A complete flora species list for all taxa identified during recent surveys of the Mainland GTP RoW and adjacent areas as listed in Table 9.2 is presented in Table 9.7. In total, 324 flora species have been recorded within or adjacent to the Mainland GTP RoW (URS 2008, GHD 2010a, and Ecologica Consulting 2010).

Of these 324 flora species, 264 species (81.5%) are native, whilst 60 (18.5%) are exotic.

Of the native flora species recorded, 251 (95.1%) are listed as Least Concern under the provisions of the NC Act.



Table 9.7 Flora species list of the Mainland GTP RoW

Family	Scientific name	Common name	NC Act status	EPBC Act status	Notes	Source
Canopy						
Boraginaceae	<i>Ehretia grahamii</i>	Rough leaved koda	LC	-	-	URS 2009
Caesalpiniaceae	<i>Cassia brewsteri</i>	Leichhardt bean	LC	-	-	URS 2008
Caesalpiniaceae	<i>Lysiphyllum hookeri</i>	White bauhina	LC	-	-	URS 2008
Capparaceae	<i>Callitris endlicheri</i>	Black cypress pine	LC	-	-	URS 2008
Casuarinaceae	<i>Casuarina cristata</i>	Belah	LC	-	-	URS 2008
Casuarinaceae	<i>Casuarina cunninghamiana</i>	River sheoak	LC	-	-	URS 2008/9
Cupressaceae	<i>Callitris glaucophylla</i>	Cypress pine	LC	-	-	URS 2008
Ebenaceae	<i>Diospyros geminata</i>	Scaly ebony	LC	-	-	URS 2008/9
Euphorbiaceae	<i>Mallotus philippensis</i>	Kamala	LC	-	-	URS 2008
Flacourtiaceae	<i>Homalium alnifolium</i>	-	LC	-	-	URS 2009
Meliaceae	<i>Melia azedarach</i>	White cedar	LC	-	-	URS 2008
Mimosaceae	<i>Archidendropsis basaltica</i>	Dead finish	LC	-	-	URS 2008
Mimosaceae	<i>Archidendropsis thozetiana</i>	Southern siris	LC	-	-	URS 2009
Moraceae	<i>Ficus virens</i>	White fig	LC	-	-	URS 2008
Myrtaceae	<i>Angophora floribunda</i>	Rough-barked apple	LC	-	-	URS 2008
Myrtaceae	<i>Angophora leiocarpa</i>	Rusty gum	LC	-	-	URS 2009
Myrtaceae	<i>Corymbia citriodora</i> subsp. <i>citriodora</i>	Lemon-scented gum	LC	-	-	URS 2008/9
Myrtaceae	<i>Corymbia clarksoniana</i>	Clarkson's bloodwood	LC	-	-	URS 2008/9
Myrtaceae	<i>Corymbia cloeziana</i>	Gympie messmate	LC	-	-	URS 2008
Myrtaceae	<i>Corymbia erythrophloia</i>	Gum-topped bloodwood	LC	-	-	URS 2008
Myrtaceae	<i>Corymbia intermedia</i>	Pink bloodwood	LC	-	-	URS 2008
Myrtaceae	<i>Corymbia tessellaris</i>	Moreton bay ash	LC	-	-	URS 2008/9
Myrtaceae	<i>Corymbia trachyphloia</i>	Brown bloodwood	LC	-	-	URS 2008
Myrtaceae	<i>Corymbia watsoniana</i> subsp. <i>capillata</i>	Large-fruited yellow jacket	LC	-	-	URS 2008





Family	Scientific name	Common name	NC Act status	EPBC Act status	Notes	Source
Myrtaceae	<i>Corymbia watsoniana</i> subsp. <i>watsoniana</i>	Large-fruited yellow jacket	LC	-	-	URS 2009
Myrtaceae	<i>Eucalyptus cambageana</i>	Dawson gum	LC	-	-	URS 2008
Myrtaceae	<i>Eucalyptus coolabahs</i>	Coolibah	LC	-	-	URS 2008
Myrtaceae	<i>Eucalyptus crebra</i>	Narrow-leaved ironbark	LC	-	-	URS 2008/9
Myrtaceae	<i>Eucalyptus decorticans</i>	Gum-topped ironbark	LC	-	-	URS 2008
Myrtaceae	<i>Eucalyptus exserta</i>	Queensland peppermint	LC	-	-	URS 2008/9
Myrtaceae	<i>Eucalyptus melanophloia</i>	Silver-leaved ironbark	LC	-	-	URS 2008
Myrtaceae	<i>Eucalyptus moluccana</i>	Gum-topped box	LC	-	-	URS 2008/9
Myrtaceae	<i>Eucalyptus orgadophila</i>	Mountain coolibah	LC	-	-	URS 2008
Myrtaceae	<i>Eucalyptus populnea</i>	Poplar box	LC	-	-	URS 2008
Myrtaceae	<i>Eucalyptus tenuipes</i>	Narrow-leaved white mahogany	LC	-	-	URS 2008
Myrtaceae	<i>Eucalyptus tereticornis</i>	Queensland blue gum	LC	-	-	URS 2008/9
Myrtaceae	<i>Gossia acmenoides</i>	-	LC	-	-	URS 2009
Myrtaceae	<i>Lophostemon confertus</i>	Brush box	LC	-	-	URS 2009
Myrtaceae	<i>Lophostemon suaveolens</i>	Swamp box	LC	-	-	URS 2008/9
Myrtaceae	<i>Lysicarpus angustifolius</i>	Budgeroo	LC	-	-	URS 2008
Myrtaceae	<i>Melaleuca fluviatilis</i>	Teatree	LC	-	-	URS 2009
Myrtaceae	<i>Melaleuca quinquenervia</i>	Paper tea-tree	LC	-	-	URS 2008/9
Myrtaceae	<i>Melaleuca viridiflora</i>	Broad leaved tea-tree	LC	-	-	URS 2008
Pittosporaceae	<i>Auranticarpa rhombifolia</i>	Queensland pittosporum	LC	-	-	URS 2008
Rutaceae	<i>Flindersia australis</i>	Crow's ash	LC	-	-	URS 2008
Simaroubaceae	<i>Ailanthus triphysa</i>	White bean	LC	-	-	URS 2009
Steruliaceae	<i>Brachychiton australis</i>	Broad-leaved bottletree	LC	-	Type A	URS 2008/9
Steruliaceae	<i>Brachychiton populneus</i>	Kurrajong	LC	-	Type A	URS 2008
Steruliaceae	<i>Brachychiton rupestris</i>	Narrow-leaved bottletree	LC	-	Type A	URS 2008



Family	Scientific name	Common name	NC Act status	EPBC Act status	Notes	Source
Mid-storey						
Anacardiaceae	<i>Euroschinus falcatus</i> var. <i>falcatus</i>	Cudgerie	LC	-	-	URS 2008
Apocynaceae	<i>Alstonia constricta</i>	Bitter bark	LC	-	-	URS 2008
Arecaceae	<i>Livistona decora</i>	Weeping cabbage palm	LC	-	Type A	Ecologica Consulting 2010
Boraginaceae	<i>Cordia dichotoma</i>	Indian cherry	LC	-	-	URS 2008
Caesalpiniaceae	<i>Cassia tomentella</i>	-	LC	-	-	URS 2008
Casuarinaceae	<i>Allocasuarina inophloia</i>	Thready-barked she-oak	LC	-	-	URS 2009
Celastraceae	<i>Denhamia oleaster</i>	Stiff denhamia	LC	-	-	URS 2009
Celastraceae	<i>Denhamia pittosporoides</i>	Veiny denhamia	LC	-	-	URS 2009
Celastraceae	<i>Elaeodendron austral</i>	Red olive plum	LC	-	-	URS 2008
Celastraceae	<i>Elaeodendron australe</i> var. <i>integrifolium</i>	-	LC	-	-	URS 2008
Celastraceae	<i>Maytenus silvestris</i>	Narrow-leaved orangebark	LC	-	-	URS 2009
Combretaceae	<i>Terminalia oblongata</i>	Yellow-wood	LC	-	-	URS 2008/9
Erythroxylaceae	<i>Erythroxylum austral</i>	Cocainne tree	LC	-	-	URS 2008
Euphorbiaceae	<i>Croton insularis</i>	Silver croton	LC	-	-	URS 2009
Fabaceae	<i>Erythrina vespertilio</i>	Bat's wing coral tree	LC	-	-	URS 2008
Fabaceae	<i>Leucaena leucocephala</i> *	Leucaena	-	-	-	URS 2009
Mimosaceae	<i>Acacia catenulate</i>	Bendee	LC	-	-	URS 2009
Mimosaceae	<i>Acacia gittinsii</i>	Gittins wattle	NT	-	-	Ecologica Consulting 2010
Mimosaceae	<i>Acacia nilotica</i> subsp. <i>indica</i> *	Prickly acacia	-	WONS	Class 2	GHD 2010
Mimosaceae	<i>Acacia spania</i>	-	NT	-	-	Ecologica Consulting 2010
Meliaceae	<i>Owenia acidula</i>	Emu apple	LC	-	-	URS 2008
Moraceae	<i>Ficus opposite</i>	Sandpaper fig	LC	-	-	URS 2008
Moraceae	<i>Ficus rubiginosa</i>	Rock fig	LC	-	-	URS 2009
Myoporaceae	<i>Eremophila mitchellii</i>	False sandalwood	LC	-	-	URS 2008
Myoporaceae	<i>Myoporum acuminatum</i>	Coastal boobialla	LC	-	-	URS 2008



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Myrtaceae	<i>Homoranthus decasetus</i>	Red mouse bush	NT	-	-	Ecologica Consulting 2010
Myrtaceae	<i>Melaleuca bracteata</i>	Black tea-tree	LC	-	-	URS 2008
Myrtaceae	<i>Melaleuca leucadendra</i>	Weeping tea-tree	LC	-	-	URS 2008
Myrtaceae	<i>Melaleuca linariifolia</i>	Snow-in-summer	LC	-	-	URS 2008
Myrtaceae	<i>Melaleuca viminalis</i>	Weeping bottlebrush	LC	-	-	URS 2008/9
Oleaceae	<i>Notelaea microcarpa</i>	Native olive	LC	-	-	URS 2008
Phytolaccaceae	<i>Petalostigma pubescens</i>	Quinine tree	LC	-	-	URS 2008
Pittosporaceae	<i>Bursaria incana</i>	Prickly pine	LC	-	-	URS 2008
Pittosporaceae	<i>Bursaria spinosa</i>	Blackthorn	LC	-	-	URS 2008/9
Pittosporaceae	<i>Pittosporum spinescens</i>	Large-fruited orange thorn	LC	-	-	URS 2008
Proteaceae	<i>Grevillea sessilis</i>	-	LC	-	-	URS 2008
Proteaceae	<i>Grevillea striata</i>	Beefwood	LC	-	-	URS 2008
Putranjivaceae	<i>Drypetes deplanchei</i>	Yellow tulipwood	LC	-	-	URS 2008/9
Rhamnaceae	<i>Alphitonia excelsa</i>	Red ash	LC	-	-	URS 2008/9
Rubiaceae	<i>Everistia vacciniifolia</i>	-	LC	-	-	URS 2008
Rutaceae	<i>Geijera parviflora</i>	Wilga	LC	-	-	URS 2008
Rutaceae	<i>Geijera salicifolia</i>	Brush wilga	LC	-	-	URS 2008/9
Rutaceae	<i>Micromelum minutum</i>	Cluster berry	LC	-	-	URS 2009
Santalaceae	<i>Exocarpus cupressiformis</i>	Bush cherry	LC	-	-	URS 2008
Sapindaceae	<i>Alectryon conatus</i>	Grey birds-eye	LC	-	-	URS 2008
Sapindaceae	<i>Alectryon oleifolius</i>	Western rosewood	LC	-	-	URS 2008
Sapindaceae	<i>Atalaya hemiglauca</i>	Whitewood	LC	-	-	URS 2008
Sapindaceae	<i>Atalaya salicifolia</i>	Scrub whitewood	LC	-	-	URS 2008
Sapindaceae	<i>Cupaniopsis anacardioides</i>	Tuckeroo	LC	-	-	URS 2008
Sapotaceae	<i>Pouteria sericea</i>	Mongo	LC	-	-	URS 2008
Ulmaceae	<i>Celtis sinensis</i> *	Chinese celtis	-	-	Class 3	URS 2008; GHD 2010



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Verbenaceae	<i>Clerodendrum floribundum</i>	Lolly bush	LC	-	-	URS 2008
Shrub layer						
Apocynaceae	<i>Alyxia ruscifolia</i> subsp. <i>ruscifolia</i>	Chainfruit	LC	-	-	URS 2009
Apocynaceae	<i>Carissa ovate</i>	Currant bush	LC	-	-	URS 2008/9
Apocynaceae	<i>Cascabela thevetia</i> *	Yellow oleander	-	-	Class 3	GHD 2010
Asteraceae	<i>Cassinia laevis</i>	Cough bush	LC	-	-	URS 2008
Asteraceae	<i>Senecio pinnatifolius</i> ⁺	Native fireweed	LC	-	-	GHD 2010
Byttneriaceae	<i>Keraudrenia hookeriana</i>	-	LC	-	-	URS 2008
Cactaceae	<i>Harrisia martinii</i> * (formerly <i>Eriocereus martinii</i>)	Harrisia cactus	-	-	Class 2	URS 2008; GHD 2010
Cactaceae	<i>Opuntia stricta</i> var. <i>stricta</i> *	Common prickly pear	-	-	Class 2	URS 2008/9; GHD 2010
Cactaceae	<i>Opuntia tomentosa</i> *	Velvety tree pear	-	-	Class 2	URS 2008; GHD 2010
Caesalpiaceae	<i>Senna artemisioides</i>	Desert cassia	LC	-	-	URS 2008
Capparaceae	<i>Capparis canescens</i>	Wild orange	LC	-	-	URS 2009
Capparaceae	<i>Capparis lasiantha</i>	Wild orange	LC	-	-	URS 2008
Capparaceae	<i>Capparis loranthifolia</i>	Capper bush	LC	-	-	URS 2008
Capparaceae	<i>Capparis ornans</i>	Capper bush	LC	-	-	URS 2008
Celastraceae	<i>Apatophyllum teretifolium</i>	-	NT	-	-	Ecologica Consulting 2010
Chenopodiaceae	<i>Maireana microphylla</i>	Small-leaf bluebush	LC	-	-	URS 2009
Chenopodiaceae	<i>Sclerolaena birchii</i> ⁺	Galvanised burr	LC	-	-	GHD 2010
Cycadaceae	<i>Cycas megacarpa</i>	Cycad	E	E	-	URS 2008
Euphorbiaceae	<i>Acalypha eremorum</i>	Acalypha	LC	-	-	URS 2008
Euphorbiaceae	<i>Alchornea ilicifolia</i>	Native holly	LC	-	-	URS 2008/9
Euphorbiaceae	<i>Bertya oppositifolia</i>	Bertya	LC	V	-	Ecologica Consulting 2010
Euphorbiaceae	<i>Breynia oblongifolia</i>	Coffee bush	LC	-	-	URS 2008
Euphorbiaceae	<i>Ricinus communis</i> *	Castor oil plant	-	-	-	URS 2008



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Fabaceae	<i>Cajanus reticulates</i>	Nalta jute	LC	-	-	URS 2008
Fabaceae	<i>Daviesia filipes</i>	Pea bush	LC	-	-	URS 2008
Fabaceae	<i>Desmodium rhytidophyllum</i>	Native desmodium	LC	-	-	URS 2008
Fabaceae	<i>Hovea longipes</i>	Pea bush	LC	-	-	URS 2009
Fabaceae	<i>Indigofera hirsute</i>	Hairy indigo	LC	-	-	URS 2008
Fabaceae	<i>Jacksonia scoparia</i>	Dogwood	LC	-	-	URS 2008
Fabaceae	<i>Sesbania cannabina</i>	Sesbania pea	LC	-	-	URS 2008
Fabaceae	<i>Stylosanthes scabra</i> *	Shrubby stylo	-	-	-	URS 2008
Lamiaceae	<i>Spartothamnella juncea</i>	-	LC	-	-	URS 2008
Loganiaceae	<i>Strychnos psilosperma</i>	Strychnine tree	LC	-	-	URS 2009
Malvaceae	<i>Hibiscus divaricatus</i>	Native hibiscus	LC	-	-	URS 2008/9
Malvaceae	<i>Hibiscus sturtii</i>	Sturt's hibiscus	LC	-	-	URS 2008
Meliaceae	<i>Turraea pubescens</i>	Native honeysuckle	LC	-	-	URS 2008
Mimosaceae	<i>Acacia amblygona</i>	Fan-leaf wattle	LC	-	-	URS 2008
Mimosaceae	<i>Acacia barakulensis</i>	Waaje wattle	V	-	-	URS 2008
Mimosaceae	<i>Acacia complanata</i>	Flat-stemmed wattle	LC	-	-	URS 2008
Mimosaceae	<i>Acacia decora</i>	Pretty wattle	LC	-	-	URS 2008/9
Mimosaceae	<i>Acacia disparrima</i>	Hickory wattle	LC	-	-	URS 2008/9
Mimosaceae	<i>Acacia excels</i>	Ironwood	LC	-	-	URS 2008
Mimosaceae	<i>Acacia farnesiana</i>	Mimosa bush	LC	-	-	URS 2008
Mimosaceae	<i>Acacia fasciculifera</i>	Scrub wattle	LC	-	-	URS 2008
Mimosaceae	<i>Acacia harpophylla</i>	Brigalow	LC	-	-	URS 2008
Mimosaceae	<i>Acacia irrorata</i> subsp. <i>Irrorata</i>	Green wattle	LC	-	-	URS 2008
Mimosaceae	<i>Acacia leiocalyx</i>	Black wattle	LC	-	-	URS 2008/9
Mimosaceae	<i>Acacia longispicata</i>	Slender-flowered wattle	LC	-	-	URS 2008
Mimosaceae	<i>Acacia macradenia</i>	Zigzag wattle	LC	-	-	URS 2008





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Mimosaceae	<i>Acacia pedleyi</i>	Pedley's wattle	V	-	-	URS 2008
Mimosaceae	<i>Acacia pubicosta</i>	-	NT	-	-	URS 2008
Mimosaceae	<i>Acacia salicina</i>	Sally wattle	LC	-	-	URS 2008
Mimosaceae	<i>Acacia shirleyi</i>	Lancewood	LC	-	-	URS 2008
Mimosaceae	<i>Acacia tenuinervis</i>	-	NT	-	-	URS 2009
Myrtaceae	<i>Melaleuca irbyana</i>	Swamp tea-tree	E	-	-	Ecologica Consulting 2010
Myoporaceae	<i>Eremophila debilis</i>	Winter apple	LC	-	-	URS 2008
Polygonaceae	<i>Muehlenbeckia florulenta</i>	Lignum	LC	-	-	URS 2008
Rubiaceae	<i>Pogonolobus reticulatus</i>	Medicine bush	LC	-	-	URS 2008/9
Rubiaceae	<i>Psychotria daphnoides</i>	-	LC	-	-	URS 2008
Rubiaceae	<i>Psydrax odorata</i>	Large-leaved canthium	LC	-	-	URS 2008
Rutaceae	<i>Citrus glauca</i>	Inland lime	LC	-	-	URS 2008
Santalaceae	<i>Santalum lanceolatum</i>	True sandalwood	LC	-	-	URS 2008
Sapindaceae	<i>Alectryon diversifolius</i>	Scrub boonaree	LC	-	-	URS 2008
Sapindaceae	<i>Cupaniopsis wadsworthii</i>	-	LC	-	-	URS 2009
Solanaceae	<i>Solanum johnsonianum</i>	-	E	-	-	Ecologica Consulting 2010
Solanaceae	<i>Solanum parvifolium</i>	-	LC	-	-	URS 2008
Solanaceae	<i>Solanum torvum</i> *	Devils' fig	-	-	-	URS 2009
Sparrmanniaceae	<i>Grewia retusifolia</i>	Dysentery bush	LC	-	-	URS 2008
Thymelaeaceae	<i>Wikstroemia indica</i>	Tie bush	LC	-	-	URS 2008
Verbenaceae	<i>Lantana camara</i> *	Lantana	-	WONS	Class 3	URS 2008/9; GHD 2010
Xanthorrhoeaceae	<i>Xanthorrhoea johnsonii</i>	Grass tree	LC	-	Type A	URS 2008/9
Ground layer						
Acanthaceae	<i>Rostellularia adscendens</i>	-	LC	-	-	URS 2008
Acanthaceae	<i>Rostellularia obtusa</i>	-	LC	-	-	URS 2008
Adiantaceae	<i>Cheilanthes distans</i>	Bristly cloak fern	LC	-	-	URS 2009



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Adiantaceae	<i>Cheilanthes sieberi</i>	Mulga fern	LC	-	-	URS 2008
Aizoaceae	<i>Tetragonia tetragonioides</i>	New Zealand spinach	LC	-	-	URS 2008
Amaranthaceae	<i>Achyranthes aspera</i>	Chaff flower	LC	-	-	URS 2008
Amaranthaceae	<i>Alternanthera pungens</i> *	Khaki weed	-	-	-	URS 2008; GHD 2010
Amaranthaceae	<i>Gomphrena celosioides</i> *	Gomphrena weed	-	-	-	URS 2008
Amaranthaceae	<i>Nyssanthes erecta</i>		LC	-	-	URS 2008
Amaryllidaceae	<i>Crinum flaccidum</i>	Murray lily	LC	-	-	URS 2008
Amaryllidaceae	<i>Crinum pedunculatum</i>	Swamp lily	LC	-	-	URS 2008
Asclepiadaceae	<i>Asclepias curassavica</i> *	Redhead cotton bush	-	-	-	URS 2008/9
Asclepiadaceae	<i>Gomphocarpus physocarpus</i> *	Balloon cotton bush	-	-	-	URS 2008
Asteraceae	<i>Ageratum houstonianum</i> *	Blue billy goat weed	-	-	-	URS 2008
Asteraceae	<i>Bidens pilosa</i> var. <i>pilosa</i> *	Cobblers pegs	-	-	-	URS 2008; GHD 2010
Asteraceae	<i>Calotis cuneifolia</i>	Burr daisy	LC	-	-	URS 2008
Asteraceae	<i>Calotis hispidula</i>	Bogan flea	LC	-	-	URS 2008
Asteraceae	<i>Calotis lappulacea</i>	Yellow burr daisy	LC	-	-	URS 2008
Asteraceae	<i>Cirsium vulgare</i> *	Spear thistle	-	-	-	URS 2008
Asteraceae	<i>Cyanthillium cinereum</i>	Vernonia	LC	-	-	URS 2008
Asteraceae	<i>Emilia sonchifolia</i> var. <i>sonchifolia</i> *	Emilia	-	-	-	URS 2008
Asteraceae	<i>Parthenium hysterophorus</i> *	Parthenium weed	-	WONS	Class 2	URS 2008; GHD 2010
Asteraceae	<i>Peripleura hispidula</i> var. <i>setose</i>	-	LC	-	-	URS 2008
Asteraceae	<i>Praxelis clematidea</i> *	Praxelis	-	-	-	GHD 2010
Asteraceae	<i>Pterocaulon sphacelatum</i>	Applebush	LC	-	-	URS 2008
Asteraceae	<i>Senecio brigalowensis</i>	-	LC	-	-	URS 2008
Asteraceae	<i>Sigesbeckia orientalis</i>	Indian weed	LC	-	-	URS 2008
Asteraceae	<i>Sonchus oleraceus</i> *	Sow thistle	-	-	-	URS 2008
Asteraceae	<i>Tridax procumbens</i> *	Tridax daisy	-	-	-	URS 2008



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Asteraceae	<i>Xanthium occidentale</i> *	Noogoora burr	-	-	-	GHD 2010
Asteraceae	<i>Xanthium spinosum</i> *	Bathurst burr	-	-	-	URS 2008; GHD 2010
Campanulaceae	<i>Wahlenbergia islensis</i>	Native bluebell	NT	-	-	Ecologica Consulting 2010
Chenopodiaceae	<i>Atriplex muelleri</i>	Annual saltbush	LC	-	-	URS 2008
Chenopodiaceae	<i>Einadia nutans</i>	Climbing saltbush	LC	-	-	URS 2008
Chenopodiaceae	<i>Enchylaena tomentosa</i>	Ruby saltbush	LC	-	-	URS 2008
Chenopodiaceae	<i>Salsola kali</i>	Soft roly poly	LC	-	-	URS 2008
Commelinaceae	<i>Commelina diffusa</i>	Wandering jew	LC	-	-	URS 2008
Convolvulaceae	<i>Evolvulus alsinoides</i>	Blue periwinkle	LC	-	-	URS 2008
Crassulaceae	<i>Bryophyllum delagoense</i> *	Mother of millions	-	-	Class 2	URS 2008; GHD 2010
Cyperaceae	<i>Cyperus gracilis</i>	Graceful sedge	LC	-	-	URS 2008
Cyperaceae	<i>Cyperus tuberosus</i> *	Nutgrass	-	-	-	URS 2008
Cyperaceae	<i>Scleria brownie</i>	-	LC	-	-	URS 2008
Cyperaceae	<i>Scleria sphacelata</i>	-	LC	-	-	URS 2008
Fabaceae	<i>Crotalaria pallida</i> *	Streaked rattlepod	-	-	-	URS 2008
Fabaceae	<i>Cullen tenax</i>	Emu foot	LC	-	-	URS 2008
Fabaceae	<i>Swainsona microphylla</i>	-	LC	-	-	URS 2008
Haloragaceae	<i>Gonocarpus urceolatus</i>	Raspweed	V	-	-	Ecologica Consulting 2010
Hemerocallidaceae	<i>Dianella caerulea</i>	Blue flax lilly	LC	-	-	URS 2009
Hemerocallidaceae	<i>Dianella revolute</i>	Blueberry lilly	LC	-	-	URS 2008
Juncaceae	<i>Juncus polyanthemus</i>	-	LC	-	-	URS 2008
Malvaceae	<i>Malvastrum americanum</i>	Spiked malvastrum	LC	-	-	URS 2008
Malvaceae	<i>Sida cordifolia</i> *	Flannel weed	-	-	-	URS 2008
Malvaceae	<i>Sida hackettiana</i>	-	LC	-	-	URS 2008
Malvaceae	<i>Sida rhombifolia</i> *	Common flannel weed	-	-	-	URS 2008
Malvaceae	<i>Sida subspicata</i>	Spiked sida	LC	-	-	URS 2009



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Marsileaceae	<i>Marsilea hirsute</i>	Short-fruit nardoo	LC	-	-	URS 2008
Menyanthaceae	<i>Nymphoides indica</i>	Water snowflake	LC	-	-	URS 2008
Mimosaceae	<i>Neptunia gracilis</i>	Native sensitive plant	LC	-	-	URS 2008
Onagraceae	<i>Ludwigia octovalvis</i>	Willow primrose	LC	-	-	URS 2008
Oxalidaceae	<i>Oxalis corniculata</i> var. <i>corniculata</i> *	Creeping oxalis	-	-	-	URS 2008
Papaveraceae	<i>Argemone ochroleuca</i> *	Mexican poppy	-	-	-	URS 2008
Phyllanthaceae	<i>Phyllanthus virgatus</i>	Hen and chicken	LC	-	-	URS 2008
Poaceae	<i>Aristida calycina</i>	Dark wiregrass	LC	-	-	URS 2008/9
Poaceae	<i>Aristida caput-medusae</i>	Many headed wire grass	LC	-	-	URS 2008
Poaceae	<i>Aristida jerichoensis</i>	Jericho wiregrass	LC	-	-	URS 2008
Poaceae	<i>Aristida leptopoda</i>	White speargrass	LC	-	-	URS 2008
Poaceae	<i>Aristida personata</i>	Purple wire-grass	LC	-	-	URS 2008
Poaceae	<i>Arundinella nepalensis</i>	Reed grass	LC	-	-	URS 2008/9
Poaceae	<i>Austrostipa verticillata</i>	Slender bamboo grass	LC	-	-	URS 2008
Poaceae	<i>Bothriochloa pertusa</i> *	Indian bluegrass	-	-	-	URS 2008
Poaceae	<i>Bothriochloa decipiens</i> var <i>decipiens</i>	Pitted bluegrass	LC	-	-	URS 2008
Poaceae	<i>Bothriochloa erianthoides</i>	Satintop grass	LC	-	-	URS 2008
Poaceae	<i>Cenchrus echinatus</i> *	Mossman river grass	-	-	-	URS 2008
Poaceae	<i>Chionachne cyathopoda</i>	River grass	LC	-	-	URS 2008
Poaceae	<i>Chloris inflata</i> *	Purpletop chloris	-	-	-	URS 2008
Poaceae	<i>Chloris virgata</i> *	Feathertop rhodes grass	-	-	-	URS 2008/9; GHD 2010
Poaceae	<i>Chrysocephalum apiculatum</i>	Yellow buttons	LC	-	-	URS 2008
Poaceae	<i>Cymbopogon obtectus</i>	Silky head	LC	-	-	URS 2008
Poaceae	<i>Cymbopogon refractus</i>	Barbwire grass	LC	-	-	URS 2008
Poaceae	<i>Cynodon dactylon</i>	Coach grass	LC	-	-	URS 2008
Poaceae	<i>Dichanthium aristatum</i> *	Angleton grass	LC	-	-	URS 2008



Family	Scientific name	Common name	NC Act status	EPBC Act status	Notes	Source
Poaceae	<i>Dichanthium sericeum</i> subsp. <i>sericeum</i>	Queensland blue grass	LC	-	-	URS 2008
Poaceae	<i>Echinochloa colona</i> *	Awnless barnyard grass	-	-	-	URS 2008
Poaceae	<i>Enneapogon lindleyanus</i>	Wiry nineawn	LC	-	-	URS 2008
Poaceae	<i>Enneapogon pallidus</i>	Conetop nineawn	LC	-	-	URS 2008
Poaceae	<i>Enteropogon unispiceus</i>	-	LC	-	-	URS 2008
Poaceae	<i>Entolasia stricta</i>	Wiry panic	LC	-	-	URS 2008
Poaceae	<i>Eragrostis brownie</i>	Brown's lovegrass	LC	-	-	URS 2008/9
Poaceae	<i>Eragrostis curvula</i> *	African lovegrass	-	-	-	GHD 2010
Poaceae	<i>Eragrostis spartinoides</i>	Love grass	LC	-	-	URS 2008
Poaceae	<i>Eriochloa pseudoacrotricha</i>	Early spring grass	LC	-	-	URS 2008
Poaceae	<i>Heteropogon contortus</i>	Giant speargrass	LC	-	-	URS 2008/9
Poaceae	<i>Hyparrhenia rufa</i> *	Thatch grass	-	-	-	URS 2008
Poaceae	<i>Imperata cylindrical</i>	Blady grass	LC	-	-	URS 2008
Poaceae	<i>Leptochloa digitata</i>	Umbrella cane grass	LC	-	-	URS 2008
Poaceae	<i>Megathyrsus maximus</i> *	Guinea grass	-	-	-	URS 2008/9
Poaceae	<i>Melinis repens</i> *	Red natal grass	-	-	-	URS 2008
Poaceae	<i>Oplismenus aemulus</i>	Creeping beard grass	LC	-	-	URS 2008
Poaceae	<i>Ottochloa gracillima</i>	Graceful grass	LC	-	-	URS 2008
Poaceae	<i>Panicum decompositum</i>	Native millet	LC	-	-	URS 2008
Poaceae	<i>Panicum effusum</i>	Hairy panicum	LC	-	-	URS 2008/9
Poaceae	<i>Pennisetum ciliare</i> *	Buffel grass	-	-	-	URS 2008/9
Poaceae	<i>Setaria surgens</i>	Native pigeon grass	LC	-	-	URS 2008
Poaceae	<i>Sporobolus caroli</i>	Fairy grass	LC	-	-	URS 2008/9
Poaceae	<i>Sporobolus creber</i>	Native rat's tail grass	LC	-	-	URS 2008
Poaceae	<i>Sporobolus pyramidalis</i> *	Giant rat's tail grass	-	-	Class 2	URS 2009; GHD 2010
Poaceae	<i>Thellungia advena</i>	Coolibah grass	LC	-	-	URS 2008





Family	Scientific name	Common name	NC Act status	EPBC Act status	Notes	Source
Poaceae	<i>Themeda quadrivalvis</i> *	Grader grass	-	-	-	URS 2009; GHD 2010
Poaceae	<i>Themeda triandra</i>	Kangaroo grass	LC	-	-	URS 2008/9
Poaceae	<i>Tragus australianus</i>	Small burr grass	LC	-	-	URS 2008
Poaceae	<i>Triodia mitchellii</i>	Spinifex	LC	-	-	URS 2008
Poaceae	<i>Triticum</i> sp. *	Wheat	-	-	-	URS 2008
Poaceae	<i>Urochloa mosambicensis</i> *	Sabi grass	-	-	-	URS 2008
Polygonaceae	<i>Persicaria decipiens</i>	Slender knotweed	LC	-	-	URS 2008
Polygonaceae	<i>Persicaria lapathifolia</i>	Pale knotweed	LC	-	-	URS 2008
Portulacaceae	<i>Portulaca oleracea</i>	Pigweed	LC	-	-	URS 2008
Portulacaceae	<i>Portulaca pilosa</i> *	Pigweed	-	-	-	URS 2008
Scrophulariaceae	<i>Scoparia dulcis</i> *	Scoparia	-	-	-	URS 2008
Solanaceae	<i>Physalis minima</i>	Wild gooseberry	LC	-	-	URS 2008
Ulmaceae	<i>Trema tomentosa</i>	Poison peach	LC	-	-	URS 2008
Verbenaceae	<i>Lantana montevidensis</i> *	Creeping lantana	-	-	Class 3	URS 2008; GHD 2010
Verbenaceae	<i>Stachytarpheta jamaicensis</i> *	Jamacian snake vine	-	-	-	URS 2008
Verbenaceae	<i>Verbena aristigera</i> *	Mayne's pest	-	-	-	URS 2008
Verbenaceae	<i>Verbena bonariensis</i> *	Purple top	-	-	-	URS 2008
Xanthorrhoeaceae	<i>Lomandra confertifolia</i> subsp. <i>pallida</i>	Matrush	LC	-	-	URS 2009
Xanthorrhoeaceae	<i>Lomandra hystrix</i>	Matrush	LC	-	-	URS 2008
Xanthorrhoeaceae	<i>Lomandra longifolia</i>	Spiny-headed mat rush	LC	-	-	URS 2008/9
Xanthorrhoeaceae	<i>Lomandra multiflora</i>	Many-flowered mat rush	LC	-	-	URS 2008
Zamiaceae	<i>Macrozamia macleayi</i>	Cycad	LC	-	Type A	URS 2008
Zamiaceae	<i>Macrozamia miquelii</i>	Cycad	LC	-	Type A	URS 2009
Vines/creepers						
Apocynaceae	<i>Sarcostemma viminale</i>	Caustic vine	LC	-	-	URS 2008
Apocynaceae	<i>Secamone elliptica</i>	Secamone	LC	-	-	URS 2008



Family	Scientific name	Common name	NC Act status	EPBC Act status	Notes	Source
Aristolochiaceae	<i>Aristolochia elegans</i> *	Dutchman's Pipe	-	-	Class 3	GHD 2010
Asclepiadaceae	<i>Cryptostegia grandiflora</i> *	Rubber vine	-	WONS	Class 2	URS 2008/9; GHD 2010
Basellaceae	<i>Anredera cordifolia</i> *	Madeira vine	-	-	Class 3	GHD 2010
Bignoniaceae	<i>Pandorea pandorana</i>	Wonga vine	LC	-	-	URS 2008
Bignoniaceae	<i>Macfadyena unguis-cati</i> *	Cats claw creeper	-	-	Class 3	URS 2008; GHD 2010
Fabaceae	<i>Glycine tabacina</i>	Glycine pea	LC	-	-	URS 2008
Fabaceae	<i>Hardenbergia violacea</i>	Native sarsparilla	LC	-	-	URS 2008
Fabaceae	<i>Rhynchosia minima</i>	Rhynchosia	LC	-	-	URS 2008
Fabaceae	<i>Macroptilium atropurpureum</i> *	Siratro	-	-	-	URS 2009
Lauraceae	<i>Cassytha filiformis</i>	Dodder laurel	LC	-	-	URS 2008
Oleaceae	<i>Jasminum didymum</i>	Native jasmine	LC	-	-	URS 2008/9
Oleaceae	<i>Jasminum simplicifolium</i>	Native jasmine	LC	-	-	URS 2008
Passifloraceae	<i>Passiflora foetida</i> *	Stinking passion flower	-	-	-	URS 2008
Passifloraceae	<i>Passiflora suberosa</i> *	Corky passion flower	-	-	-	URS 2008
Smilacaceae	<i>Eustrephus latifolius</i>	Wombat berry	LC	-	-	URS 2008/9
Vitaceae	<i>Cissus oblonga</i>	Smooth watervine	LC	-	-	URS 2009
Vitaceae	<i>Cissus opaca</i>	Forest grape	LC	-	-	URS 2008
Arboreal plants						
Loranthaceae	<i>Amyema biniflora</i>	A mistletoe	LC	-	-	URS 2008
Orchidaceae	<i>Cymbidium canaliculatum</i>	Black orchid	LC	-	Type A	URS 2008
Polypodiaceae	<i>Platynerium bifurcatum</i>	Elkhorn fern	LC	-	Type A	URS 2009

Table notes * denotes exotic species; + denotes native species considered a weed by local landholder and/or local government agencies
Status Type A = Type A Restricted least concern plant under the provisions of the NC Act; Marine = Marine Plant under the provisions of the Fish Act WONS = Weeds of National Significance; Class 2/3 = Declared weed classification under the LP Act; LC = Least Concern NT = Near Threatened; V = Vulnerable; E = Endangered; CE = Critically Endangered;
Source URS 2008 (Excludes data collected for Curtis Island ie Secondary sites 42-52 and Quaternary sites 51-70); URS 2009 (includes data for GSDA Secondary sites 1-3, and 8, and Quaternary sites 2,3,5,10,12-14 and West of Bruce Highway Secondary sites 1-6 and Quaternary sites 1-2, 6--22 (ie those survey sites within close proximity to the current alignment March 2011)); GHD 2010a; Ecologica Consulting 2010

Twelve (12) conservation significant flora species listed under the provision of the EPBC Act and/or the NC Act, that have been identified through database searches (refer Table 9.6), were identified within the Mainland GTP RoW during recent field investigations involving targeted searches (Ecologica Consulting, 2010) (refer Table 9.6 for habitat descriptions).

The *Acacia gittinsii* (Gittins wattle) and *Acacia spania* (both listed as Near Threatened (NT) under the provisions of the NC Act) have been identified within the Mainland GTP RoW, within the vicinity of KP 10.5. An additional population of *Acacia spania* has been detected at KP 131 (Figure 9.1), and a population of Gittins Wattle has been detected within the vicinity of KP 141 (Expedition Range) (within the DERM mapped Essential Habitat for this species; refer Figure 9.1 and Figure 9.2).

During targeted searches, the *Homoranthus decasetus* (Red mouse bush) (NT NC Act) was detected within the Mainland GTP RoW, in close proximity to KP 140.25 of (Ecologica Consulting, 2010). In addition, *Acacia pubicosta*, *Wahlenbergia islensis* and *Apatophyllum teretifolium* (all three mapped as NT under the provisions of the NC Act) have also been detected within the Mainland GTP RoW (Ecologica Consulting, 2010) (Figure 9.1).

Two NC Act listed vulnerable species have been detected within the Mainland GTP RoW, namely *Gonocarpus urceolatus* (Raspweed), and *Acacia pedleyi* (Pedley's wattle). Raspweed has been identified within the Mainland GTP RoW within the vicinity of KP 9.25, whilst a population of Pedley's wattle has been identified within the Callide Timber Reserve (KP 314.75), in association with the DERM Essential Habitat mapping (Ecologica Consulting, 2010) (Figure 9.1 and 9.2).

Bertya opponens (listed as Vulnerable under the provisions of the EPBC Act) has been recorded within the Least Concern complex RE11.10.3/RE11.3.25 (KP 20.5), in association with Baffle Creek (Ecologica Consulting, 2010) (Figure 9.1 and 9.2).

Melaleuca irbyana (Bushhouse paperbark) and *Solanum johnsonianum* are both listed under the provisions of the NC Act as endangered, and have both been detected within the Mainland GTP RoW. Bushhouse paperbark has been recorded at one location within the RoW, within close proximity to KP 11, whilst *Solanum johnsonianum* has been detected within close proximity to KP 243.25 (Kianga Creek) (Ecologica Consulting, 2010) (Figure 9.1).

Cycas megacarpa (Large-fruited zamia palm) (listed as endangered under the provisions of the EPBC Act and NC Act) has been detected at a number of locations within the Mainland GTP RoW, particularly in association with the Callide Timber Reserve (KP 314.5 – 329.25), and the remnant and regrowth vegetation along the Dawson Highway (KP 338.25, and KP 399 - 400) (Ecologica Consulting, 2010) (Figures 9.1 and 9.2).

An additional species listed under the provisions of the NC Act, namely *Acacia tenuinervis* (near threatened), is known to occur within the Mainland GTP RoW, despite its omission from the database search results (EPBC Act 2011; Wildlife Online 2011) (URS, 2009). This species typically occurs on red soils, sandstone derived soils and ironstone gravel on ridges and slopes in poplar and ironbark forests, brigalow and disturbed environments such as road verges. This species is thought to be restricted within south-east Queensland between north-west of Injune to west of Monto, including the Expedition Range.

Two species identified in Table 9.6 are considered to have a 'high' likelihood of occurrence within the Mainland GTP RoW based on the presence of potentially suitable habitat and/or the location of the RoW within the species' known distribution. These species include *Solanum dissectum* and *Solanum elachophyllum*. Refer Table 9.6 for habitat descriptions.

No marine plants (as defined by the *Fisheries Act 1994*) have been identified within the Mainland GTP RoW.

Fifteen (15) of the exotic species (refer Table 9.7 and Table 9.8) are declared weeds under the provisions of the Queensland *Land Protection (Pest and Stock Route Management) Act 2002* (LP Act). The remaining 45 exotic species identified are considered general environmental weeds (Table 9.7).

Queensland Type A Restricted Plants

In accordance with the CG Report, consideration has been made to Type A restricted least concern plants (Type A plants) that occur within the Mainland GTP RoW.

The following is a list of Type A plants, declared under the provisions of the NC Act:

- a plant of the family Orchidaceae (other than *Spathoglottis plicata*)
- a plant of the genus *Xanthorrhoea* (grass trees)
- a plant of the genus *Myrmecodia* (ant plants)
- a plant of the genus *Hydnophytum* (ant plants)
- a plant of the family Cycadaceae¹ (cycads)
- a plant of the family Zamiaceae (cycads)
- a plant of the genus *Huperzia* (lace plants)
- a plant of the family Platycerium (staghorns and elkhorns)
- a plant of the genus *Brachychiton* (bottle trees)
- a plant of the genus *Livistona* (cabbage palms)

Nine (9) Type A restricted plants, as defined by the provisions of the NC Act, have been detected within the Mainland GTP RoW, and include Orchids, Bottle trees (*Brachychiton* spp.), Grass trees (*Xanthorrhoea* spp.) Cabbage palms (*Livistona decora*), Staghorns/Elkhorns and Macrozamia (*Macrozamia* spp) (refer Table 9.7).

Weeds of National and State Significance

A review of the EPBC Act Protected Matters databases (DSEWPC, 2011) identified ten species, listed as Weeds of National Significance (WONS) under the National Weed Management Strategy, as potentially occurring within a 5 km radius of the Mainland GTP RoW (refer Table 9.8). These species are also considered declared weeds under the LP Act.

¹ Excludes conservation significant Orchid species (eg *Cycas megacarpa*)

Table 9.8 Weeds of National significance potentially occurring within the Mainland GTP RoW

Scientific name	Common name	LP Act Class ² .
<i>Alternanthera philoxeroides</i>	Alligator weed	1
<i>Acacia nilotica</i> subsp. <i>indica</i>	Prickly acacia	2
<i>Chrysanthemoides monilifera</i>	Bitou bush	1
<i>Cryptostegia grandiflora</i>	Rubber vine	2
<i>Hymenachne amplexicaulis</i>	Hymenachne	2
<i>Lantana camara</i>	Lantana	3
<i>Parkinsonia aculeata</i>	Parkinsonia	2
<i>Parthenium hysterophorus</i>	Parthenium	2
<i>Prosopis</i> spp.	Mesquite	1
<i>Salvinia molesta</i>	Salvinia	2

Table notes Species indicated in **BOLD** text have been observed within the RoW
Source: EPBC Act Protected Matters Search Tool, 2011; DEEDI 2011

Table 9.9 outlines weed species (declared under the provisions of the LP Act and identified in the National Weed Management Strategy) detected within or adjacent to the Mainland GTP RoW during field investigations.

Table 9.9 National and State declared weeds identified within or adjacent to the Mainland GTP RoW

Scientific name	Common name	WONS	LP Act Class
<i>Acacia nilotica</i> subsp. <i>Indica</i>	Prickly acacia	✓	2
<i>Anredera cordifolia</i>	Madeira vine	x	3
<i>Aristolochia elegans</i>	Dutchman's pipe	x	3
<i>Bryophyllum delagoense</i>	Mother of millions	x	2
<i>Cascabela thevetia</i>	Yellow oleander	x	3
<i>Celtis sinensis</i>	Chinese celtis	x	3
<i>Cryptostegia grandiflora</i>	Rubber vine	✓	2
<i>Harrisia martinii</i> (formerly <i>Eriocereus martinii</i>)	Harrisia cactus	x	2
<i>Lantana camara</i>	Lantana	✓	3
<i>Lantana montevidensis</i>	Creeping lantana	x	3
<i>Macfadyena unguis-cati</i>	Cat's claw creeper	x	3
<i>Opuntia stricta</i> var. <i>stricta</i>	Common prickly pear	x	2
<i>Opuntia tomentosa</i>	Velvety tree pear	x	2
<i>Parthenium hysterophorus</i>	Parthenium	✓	2
<i>Sporobolus pyramidalis</i>	Giant rat's tail grass	x	2

Table notes Source: URS 2008; URS 2009; Ecologica 2010; GHD 2010a; DEEDI 2011

2 There are three classes of declared weeds under the LP Act. These plants are targeted for control because they have, or could have, serious economic, environmental or social impacts. The three classes are as follows:

Class 1: has the potential to become a very serious pest in Queensland in the future. All landholders are required by law to keep their land free of Class 1 pests. It is a serious offence to introduce, keep, release or sell Class 1 pests without a permit.

Class 2: has already spread over substantial areas of Queensland. By law, all landholders must try to keep their land free of Class 2 pests and it is an offence to possess, sell or release these pests without a permit.

Class 3: is commonly established in parts of Queensland and a notice may be issued on a landowner to take reasonable action against the weed if it is causing, or has the potential to cause an adverse impact, on a nearby 'environmentally significant area' (eg a national park)

Fourty-four (44) introduced species that are not currently listed under the provision of the LP Act or identified as part of the National Weed Management Strategy, were detected within, or adjacent to, the RoW during flora surveys. These species are listed in Table 9.7.

9.3.4 Fauna

Conservation significant fauna species

A review of environmental databases identified 28 species, listed as significant and/or migratory under the provisions of the EPBC Act and/or the NC Act, as potentially occurring within, or within 5 km of the Mainland GTP RoW (Table 9.10).

The likelihood of their occurrence within the Mainland GTP RoW (based on the suitability of habitat) has been assessed and given a rating, as follows:

- “Known” - indicates that the species has been recorded during field investigations; a species record occurs (ie Qld Muesum); or discussions with land holders have indicated that this species occurs within the area
- “High” - indicates that good quality, suitable, habitat occurs within and/or adjacent to the RoW
- “Moderate” - indicates that potentially suitable habitat occurs within and/or adjacent to the RoW, but is considered very small or exists in a degraded state
- “Low” - indicates that suitable habitat does not occur within and/or adjacent to the RoW. This rating may also indicate that the site is outside of the recognised geographic range of the species

It should be noted that, given the terrestrial nature and location of the Mainland GTP RoW, entirely marine and/or pelagic species (eg whales, dolphins, dugongs etc) as well as shoreline-dependent marine species (eg turtles) have been omitted from this assessment.

Of the significant fauna and/or migratory/marine species listed in Table 9.10, five are known to occur within a 5 km radius of the Mainland GTP RoW.



Table 9.10 Likelihood of significant fauna species occurring within the vicinity (<5km) of the Mainland GTP RoW

Species	Common name	NC Act status	EPBC Act status	Habitat	Likelihood of occurrence
Reptiles					
<i>Delma torquata</i>	Collared Delma	V	V	<p>A secretive, burrowing skink that is active during the day. Recorded from rocky areas associated with dry, open forests. Occurs in open eucalypt and acacia woodland with and understory of native grasses and loose rocks. Also recorded from eucalypt woodland adjacent to semi-evergreen vine thicket. Shelters under rocks, fallen timber, leaf litter and in soil cracks (Richardson 2006)</p> <p>Important microhabitats for this species include rocky outcrops, cracking soils and ground cover (including perennial grass clumps, leaf litter, rocks, fallen timber, etc) (Richardson 2006)</p>	This species is known to occur in the Arcadia CSG Fields and remnant vegetation which are contiguous with the communities within the Mainland GTP RoW, including Expedition Range (Ecologica 2010)
<i>Cyclorana verrucosa</i>	Rough Collared Frog	NT		<p>This frog is grey-brown, olive-green or bright green on its back with darker patches. A pale stripe runs down the spine. There is a dark streak that runs from the snout, through the eye and tympanum to the shoulder. The groin and the backs of the thighs are grey-brown with white spots. The belly is granular and whitish. The skin on the back is warty and rough. The toes are one third webbed (Cogger 2000).</p> <p>This burrowing frog lives in open grasslands and woodlands. It is usually found near temporary pond, ditches, claypans and creeks (Cogger 2000).</p>	This species has a high likelihood of occurrence within the Mainland GTP RoW. Suitable habitat is present within the RoW in the form of open grassy woodland.





Species	Common name	NC Act status	EPBC Act status	Habitat	Likelihood of occurrence
<i>Adelotus brevis</i>	Tusked Frog	V		<p>This frog has a mottled dark brown back that is covered with small warts. There is usually a butterfly-shaped marking between the eyes and the arms and legs have dark bands. Bright red patches are located in the groin area and on the back of the legs. Males have very large heads and large 'tusks'. The belly of the male is black with white spots, while the female has a marbled black and white belly. In both sexes the belly is smooth, the fingers are unwebbed and the toes are slightly webbed (Cogger 2000).</p> <p>This frog lives in rainforests, wet sclerophyll forests and open grasslands. Usually is found under logs, stones or leaf litter near puddles, creeks and ponds (Cogger 2000).</p>	This species has a high likelihood of occurrence within the Mainland GTP RoW. Suitable habitat is present within the RoW in the form of streams associated with rainforests, wet sclerophyll forests and open grasslands.
<i>Denisonia maculata</i>	Ornamental Snake	V	V	<p>This species is known only from the Brigalow Belt region of QLD within the Fitzroy and Dawson River drainage systems and has been found to be most abundant in heavily gilgaied (melonhole) Brigalow (DSWWPC 2010)</p> <p>Important microhabitats for this species are likely to include cracking soils and ground cover (including perennial grass clumps, leaf litter, rocks, fallen timber etc) (Richardson 2006)</p>	This species has a high likelihood of occurrence within the Mainland GTP RoW. Suitable habitat is present within the RoW in the form of remnant vegetation associated with land zone 3,4 and 9. In addition, this species has been recorded from a number of locations between the Moura and Biloela, including areas along and to the north of the Dawson Highway. Key habitat would include the Dawson River floodplain and other natural levees between Moura and Biloela. This species has not been recorded south of Lake Nuga Nuga, but suitable habitat is likely to include the Dawson River near Lonesome National Park





Species	Common name	NC Act status	EPBC Act status	Habitat	Likelihood of occurrence
<i>Egernia rugosa</i>	Yakka Skink	V	V	Typically occurs among dense ground vegetation, fallen timber or rock outcrops in open dry sclerophyll forest (ironbark) or woodland, Brigalow forest, open shrub land, and lancewood forest on coarse gritty soils in the vicinity of low ranges, foothills, and undulating terrain with good drainage (Cogger 2000, DERM 2007f, Richardson 2006)	This species has a high likelihood of occurrence within the Mainland GTP RoW. This species is known from Fairview and Arcadia CSG Fields and has been recorded from Arcadia Valley, Lonesome Holding and Mt. Hutton. The Yakka skink is also known from remnant vegetation communities which are contiguous with the communities within the gas fields, including Expedition National Park (URS 2008). The Yakka skink is also known from unprotected lands near the Dawson Highway and Leichardt Highway junction, a number of unprotected areas in Arcadia Valley and also from the Burnett Highway to the north of Biloela (Richardson 2006)
<i>Furina dunmalli</i>	Dunmall's snake	V	V	Open forest and woodland, particularly Brigalow forest and woodland, growing on floodplains of deep-cracking black clay and clay loam soils. Utilises fallen timber and possibly also leaf litter and earth cracks. Most of the habitat of this species has been extensively modified for agriculture and grazing (Cogger 2000, Richardson 2006) Important microhabitats for this species include cracking soils and ground cover (including perennial grass clumps, leaf litter, rocks, fallen timber etc) (Richardson 2006)	This species has a high likelihood within the Mainland GTP RoW. This species is known from remnant vegetation communities which are contiguous with the communities with the RoW, including Expedition Range. This species has also been recorded from the Taroom area near Isla Gorge National Park and the Port Curtis area. There are no records in close proximity to the RoW, however key habitat is associated with Brigalow, especially on the cracking clays between the Expedition Range and Biloela (Ecologica 2010)



Species	Common name	NC Act status	EPBC Act status	Habitat	Likelihood of occurrence
<i>Paradelma orientalis</i>	Brigalow scaly-foot	V	V	Found on sandstone ridges, woodlands and vine thickets, including Brigalow. Shelters beneath sandstone slabs, logs, dense leaf litter and in grass tussocks, also known to climb small trees (Wilson and Swan 2003)	This species is known to occur within the Mainland GTP RoW (Ecologica 2010). The Brigalow scaly-foot has been recorded from Brigalow regrowth near the Dawson River in Lonesome National Park. In addition, the Brigalow scaly-foot is likely to inhabit remnant vegetation on land zones 4,5,7,9 and 10 within the RoW. A Queensland Museum record for this species occurs within 6 km the Mainland GTP RoW (KP 254.5)
<i>Acanthophis antarticus</i>	Death Adder	NT		<p>Like other members of the genus, the common death adder is characterised by a broad triangular head, narrow neck, short thick body and thin tail with a soft curved tip. Body colouration varies from grey to rich reddish-brown, usually with irregular dark crossbands and dark bars on the lips. The underside is whitish with black or brown flecks, while the tail-tip is cream or black. The eyes are small and inconspicuous, with a vertical pupil. Head shields are smooth to slightly rough, with the dorsal scales smooth to slightly keeled in 21 (rarely 23) midbody rows. There are 110-135 ventral scales, a single anal scale, and 35-60 subcaudal scales which are mostly single, with a few near the tip divided. This species is sexually dimorphic, with males averaging 44 cm and females 58cm, but may grow up to 100 cm. (Shine 1991; Cogger 2000; Wilson & Swan 2003).</p> <p>This species is found in a wide variety of well-drained habitats, including rainforests and wet sclerophyll forests, woodland, shrublands, grasslands and coastal heathlands, preferring sites with deep fixed leaf litter. The importance of these habitats to this species is not known. (Gow 1976; Cogger et al. 1983; Wilson & Knowles 1988; Covacevich & Wilson 1995; QPWS 2001; Morgan et al. 2002).</p>	This species has a high likelihood of occurrence within the Mainland GTP RoW. Suitable habitat is present within the RoW in the form of including rainforests and wet sclerophyll forests, woodland, shrublands, grasslands and coastal heathlands, preferring sites with deep fixed leaf litter.





Species	Common name	NC Act status	EPBC Act status	Habitat	Likelihood of occurrence
<i>Rheodytes leukops</i>	Fitzroy River turtle	V	V	The Fitzroy River turtle is found in flowing streams and permanent waterbodies. In the dry season it may be found in large, slow-flowing pools and non-flowing, permanent water holes (DERM 2007a). These waterbodies are usually rivers with large, deep, well oxygenated pools with rock, gravelly or sandy substrates, connected by shallow riffles. Their preferred areas are often associated with <i>Vallisneria</i> spp. (Ribbonweed) beds (DEWHA 2010b)	This species has a high likelihood of occurrence in the Mainland GTP RoW. This species is known to occur within the Fitzroy River catchment including the Dawson River between Moura and the Baralaba weirs. Due to the ephemeral nature of the Dawson River, it is considered likely that this species would occur within the revised crossing location(s) during periods of high flow (ie wet season). However, during the dry season, suitable habitat is not considered to be present as the active channel is predominantly dry. Other areas of the Dawson River catchment where there are large permanent pools of water during the dry season are Zamia, Mimosa, Banana and Baffle Creeks (Ecologica Consulting, 2010)
<i>Eseya albagula</i>	White throated-snapping turtle			This species was only described in 2006 and had previously been regarded as part of the more common and widely distributed northern snapping turtle <i>Eseya dentata</i> . It is distinguished from similar species by the irregular white or cream markings present on the throat and lower sides of the face. It is the largest species of snapping turtle (<i>Eseya</i> spp.) with a carapace (upper shell) length reaching 420 mm. The white-throated snapping turtle is only found in the Burnett, Fitzroy, Raglan and Mary river drainages of south-east Queensland. It prefers permanent flowing water habitats where there are suitable shelters and refuges (e.g. fallen trees).	There is a high likelihood that this species occurs within the RoW, where suitable habitat permanent flowing water habitats where there are suitable shelters and refuges (e.g. fallen trees) occurs.
<i>Strophurus taenicauda</i>	Golden-tailed gecko	NT	-	The golden-tailed gecko inhabits a wide variety of dry open forests and woodlands (cypress pine, ironbark, eucalypts with flaky or ribbon-like bark (spotted gum, Queensland blue gums), bulloak and brigalow/belah) on a range of soils (sand and sandy loams through to dense clays) (Richardson 2008, Wilson 2003, DERM 2010, QMDC 2008)	This species is known to occur within the Mainland GTP RoW. It has been recorded north of Baffle Creek within the Arcadia region (Ecologica Consulting, 2010). A Queensland Museum record for this species also occurs within 5km of the Mainland GTP RoW (KP 319.5)



Species	Common name	NC Act status	EPBC Act status	Habitat	Likelihood of occurrence
Aves					
<i>Ardea alba</i>	Great egret, White egret	S	Mi/Ma	<p>This species is a local migrant throughout Australia and inhabits shallow points of rivers, estuaries, mudflats, freshwater wetlands, irrigated pastures, dams and sewerage ponds. In eastern and northern Australia, the breeding period for this species is between November and May</p> <p>The Great Egret usually nests in colonies and builds its nest as a platform of sticks in treetops over water in swampy woodlands and mangrove communities (Pizzey and Knight 2007)</p>	There is a High likelihood that this species occurs within the RoW, where suitable habitat is present (ie irrigated pastures and freshwater wetlands)
<i>Ardea ibis</i>	Cattle egret	S	Mi/Ma	<p>This species is a local migrant throughout Australia and inhabits paddocks, pastures, croplands, garbage tips, wetlands, mudflats and drainage areas. This species is frequently associated with cattle. In Northern Australia, the breeding period for this species is between March and May. The Cattle Egret usually nests in colonies and builds its nest as a small, untidy platform of sticks in foliage in swampy woodlands (Pizzey and Knight 2007)</p>	This species has a high likelihood of occurrence within the RoW, where suitable habitat is present (ie irrigated pastures and freshwater wetlands)
<i>Ephippiorhynchus asiaticus</i>	Black-necked stork	NT	-	<p>This species primarily inhabits permanent, freshwater, terrestrial wetlands and surrounding marginal vegetation. This species has also been recorded from sewerage ponds and farm dams and is known to occasionally forage within grasslands and savannah woodlands, adjacent wetlands or within floodplain areas and intertidal wetlands (DEC 2005a, Pizzey and Knight 2007)</p>	<p>This species is known to occur within the vicinity of the RoW, where suitable habitat is present (ie irrigated pastures and freshwater wetlands). This species has been observed within the high value habitat associated with the Dawson River floodplain, Mimosa Creek, Larcom Creek. In addition, a number of palustrine wetlands have been observed within close proximity to the RoW, and may support this species following extended periods of rain (Ecologica Consulting, 2010)</p>





Species	Common name	NC Act status	EPBC Act status	Habitat	Likelihood of occurrence
<i>Erythrotriorchis radiatus</i>	Red Goshawk	E	E	The habitat for this species is generally a range of vegetation types close to permanent water and with a high diversity and abundance of prey species (EPA 2006). In partly cleared areas in eastern Qld, it is associated with gorge and escarpment country (Garnett 2000). The species hunts in open forests and gallery forests, within a home range between 50 and 200 km ² (Garnett 2000)	This species has a high likelihood of occurrence within the RoW. This species has not been identified within the RoW, however its home range can be up to 200km ² and it is likely that areas within the RoW are part of an individual's home range (eg this species has been recorded west of Mitchell, Springsure-Rolleston area and from Chesterton Range (Birddata 2010). The Dawson River, Hutton Creek and the Callipe River may provide suitable nesting habitat. This species is also likely to be associated with the sandstone ridges and escarpments within and adjacent to the RoW (Ecologica Consulting, 2010)
<i>Geophaps scripta scripta</i>	Squatter Pigeon (southern)	V	V	Squatter pigeons are usually observed in groups in grassy eucalypt woodlands on footslopes and alluvial plains or along watercourses and riverflats (Pizzey and Knight 2007)	This species is known to occur within the Mainland GTP RoW. This species is locally common and have been observed throughout the GSDA, the CISDA, the Callide and Calliope Ranges and Fairview (Ecologica Consulting, 2010)
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	S	Mi/Ma	This species is a local migrant throughout Australia and inhabits coastal areas, islands, estuaries, inlets, rivers and inland lakes (Pizzey and Knight 2007)	White-bellied sea-eagle is known to occur within the Mainland GTP RoW. This species is known to forage within the eastern and western sections of the GSDA. Nesting habitat is also associated with Larcom Creek adjacent to the Bruce Highway crossing (Ecologica Consulting, 2010)
<i>Hirundapus caudacutus</i>	White-throated Needletail	S	Mi/Ma	Usually a summer migrant to Australia. Widespread in eastern Queensland and regularly observed flying over forests, woodlands, pastoral areas, floodplains, lakes and coastlines (Pizzey and Knight 2007)	This species has a high likelihood of occurrence within the RoW. This species is likely to overfly a large portion of the RoW, including the areas within the Calliope and Callide ranges, and the GSDA (Ecologica Consulting, 2010)





Species	Common name	NC Act status	EPBC Act status	Habitat	Likelihood of occurrence
<i>Hirundo rustica</i>	Barn Swallow	S	Mi/Ma	Migrant to coastal and sub-coastal areas. Non-breeding in Australia. Found in a wide variety of habitat with the exception of the more heavily forested regions and drier inland areas. Often near water	This species has a low likelihood of occurrence within the RoW due to the absence of suitable habitat. Targeted searches within the RoW have not resulted in the detection of this species
<i>Melithreptus gularis</i>	Black-chinned honeyeater	NT	-	Drier open eucalypt woodlands of the Australian mainland, mainly along the western slopes of the Great Dividing Range and across the mid-north where they range into Spinifex scrubs	There is a moderate likelihood that this species occurs within the RoW, where suitable habitat occurs (ie open eucalypt woodlands)
<i>Merops ornatus</i>	Rainbow Bee-eater	S	Mi/Ma	This species is a local migrant along the east coast of Australia and inhabits open woodlands with sandy/loamy soils, sandridges, sandpits, riverbanks, road cuttings, beaches, dunes, cliffs, mangroves and rainforest communities (Pizzey and Knight 2007)	This species has a high likelihood of occurrence within the Mainland GTP RoW. This species is known from a number of locations within central Queensland, including the Calliope Range, Dawson River, Fairview Gas Fields and the GSDA (Ecologica 2010)
<i>Monarcha melanopsis</i>	Black-faced Monarch	S	Mi/Ma	This species is a local migrant along the east coast of Australia and it inhabits rainforest, eucalypt woodland/forest, coastal scrub and rainforest gullies. The Black-faced monarch breeds between October and January and nests in slender forks of juvenile trees and shrubs at least 1 m off the ground (Pizzey and Knight 2007)	This species has a high likelihood of occurrence within the Mainland GTP RoW. This species is known to inhabit SEVT and other vine thicket communities within the GSDA and the Calliope Range (Ecologica 2010)
<i>Monarcha trivirgatus</i>	Spectacled Monarch	S	Mi/Ma	This species is a local migrant along the east coast of Australia and inhabits the understorey of mountain/lowland rainforests, densely wooded gullies and riparian vegetation (Pizzey and Knight 2007)	This species has a high likelihood of occurrence within the Mainland GTP RoW. This species is known to inhabit SEVT and other vine thicket communities within the GSDA and the Calliope Range (Ecologica Consulting, 2010)
<i>Myiagra cyanoleuca</i>	Satin Flycatcher	S	Mi/Ma	Distributed along the east coast of Australia from far northern Queensland to Tasmania. Found in forests, woodlands, mangroves and coastal heath but avoids rainforest	This species has a low likelihood of occurrence within the Mainland GTP RoW due to the absence of suitable habitat. Targeted searches within the RoW have not resulted in the detection of this species.





Species	Common name	NC Act status	EPBC Act status	Habitat	Likelihood of occurrence
<i>Rostratula australis</i>	Australian Painted Snipe	V	V/Mi/Ma	Well vegetated shallows and margins of wetlands and other water courses	This species has a low likelihood of occurrence within the Mainland GTP RoW due to the absence of suitable habitat. Targeted searches within the RoW have not resulted in the detection of this species
<i>Rhipidura rufifrons</i>	Rufous Fantail	S	Mi/Ma	Undergrowth of rainforests as well as wetter eucalypt forests and gullies; monsoon forests, paperbarks, sub-inland and coastal scrubs; mangroves, watercourses, parks and gardens	There is a moderate likelihood that this species occurs within the RoW, where suitable habitat occurs
<i>Turnix melanogaster</i>	Black Breasted Button quail	V	V	Leaf-litter in drier rainforests, vine thickets, scrubby woodlands of eucalypts, she oaks, bottle brushes, brush box, brigalow and <i>Acacia</i> , thickets of lantana on rainforest fringes, hoop pine plantations, grain stubbles	There is a moderate likelihood that this species occurs within the RoW, where suitable habitat occurs
Mammals					
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat, Large Pied Bat	V	V	Natural roosts may depend heavily on sandstone outcrops/escarpments and this species has been observed in disused mine shafts, caves, overhangs and disused Fairy Martin (<i>Hirundo ariel</i>) nests for shelter and to raise young. It also possibly roosts in the hollows of trees in dry and wet sclerophyll forest; Cyprus-pine dominated forest; tall open eucalypt forest with a rainforest sub-canopy; sub-alpine woodland; and sandstone outcrop country. In south-eastern Qld, the species has primarily been recorded from higher altitude, moist, tall, open forest adjacent to rainforest (DSEWPC 2010b) It is considered that some populations of this species would rely in part on Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant) communities (DSEWPC 2010b)	This species has a high likelihood of occurrence within the Mainland GTP RoW. This species is known from the Expedition Range and Carnovan Gorge National Park and is likely to forage within and adjacent to the Mainland GTP RoW. In addition, suitable roosting sites have been identified within the sandstone cliffs associated with Baffle Creek. Other areas where the species may utilise suitable habitat includes the Dawson, Callide and Calliope Ranges (Ecologica Consulting, 2010)





Species	Common name	NC Act status	EPBC Act status	Habitat	Likelihood of occurrence
<i>Chalinolobus picatus</i>	Little Pied Bat	NT		Occurs most frequently in dry, open woodland communities throughout its range but has also been recorded in dry sclerophyll forests and <i>Araucarian</i> notophyll vine forests in south-east Queensland. Dry sclerophyll forests inhabited in south-east and central coastal Queensland include types dominated by <i>Corymbia citriodora</i> , <i>Eucalyptus moluccana</i> , <i>E. tereticornis</i> and ironbark species. In the central and western Darling Downs area of Queensland it has been predominantly recorded from <i>Callitris/Allocasuarina</i> dominated forests with scattered eucalypt emergents such as <i>E. dealbata</i> and <i>E. fibrosa</i> . In the more arid parts of its range in Queensland, New South Wales and South Australia it has been recorded from mulga (<i>Acacia aneura</i>) woodlands, from patches of <i>Eucalyptus largiflorens</i> woodlands (New South Wales) and riverine <i>E. camaldulensis</i> dominated communities.	This species has a high likelihood of occurrence within the Mainland GTP RoW. Suitable habitat within the RoW consists of <i>Corymbia citriodora</i> , <i>Eucalyptus tereticornis</i> and ironbark species as well as <i>Callitris/Allocasuarina</i> dominated forests with scattered eucalypt emergents .
<i>Taphozous australis</i>	Coastal Sheathtail Bat	V		The coastal sheathtail bat is distributed in a thin band along the north-east Queensland coast from Shoalwater Bay to Cape York, extending no more than a few kilometres inland. This species is believed to be unevenly distributed throughout its range, due to its reliance on coastal roosts. The coastal sheathtail bat forages within about one kilometre of the ocean, including sand dune scrub, mangroves, melaleuca swamps, coastal heathlands, open eucalypt forest, and grasslands. Coastal sheathtail bats that roost on coastal islands off Cape York Peninsula have been observed to fly to the mainland to forage.	This species has a potential likelihood of occurrence within the Mainland GTP RoW within 1 km from the coast.
<i>Phascolarctos cinereus</i>	Koala	V (SEQ)		The Koala is an arboreal herbivorous marsupial found in coastal regions of eastern and southern Australia. This species occurs in a variety of eucalypt forest and woodlands	This species has a high likelihood of occurrence within the Mainland GTP RoW.



Species	Common name	NC Act status	EPBC Act status	Habitat	Likelihood of occurrence
<i>Dasyurus hallucatus</i>	Northern Quoll	LC	E	The Northern quoll lives in a range of open woodland and open forest types preferring rocky areas. Its greatest breeding success is known to occur at sites near water (DERM 2006a). During the day it likes to hide in hollow logs, rock crevices, caves and hollow trees. In savanna landscapes, females maintain territories of about 35 hectares, with males estimated to range over 150 hectares	This species has a high likelihood of occurrence within the Mainland GTP RoW. This species is highly mobile and has been recorded from the Carnarvon, Expedition and Calliope Ranges. This species is likely to use habitat within Callide Range, Dawson Range and along the Dawson River (Ecologica Consulting, 2010)
<i>Hipposideros semoni</i>	Semon's Leaf-nosed Bat, Greater Wart-nosed Horseshoe-bat		E	Semon's Leaf-nosed Bat is found in tropical rainforest, monsoon forest, wet sclerophyll forest and open savannah woodland (DSEWPC 2010)	This species has a low likelihood of occurrence within the Mainland GTP RoW due to absence of suitable habitat
<i>Nyctophilus corbeni</i> (<i>South-eastern form</i>) (previously <i>timoriensis</i>)	Greater Long-eared Bat, South-eastern Long-eared Bat	V	V	This species occurs in a range of inland woodland vegetation types, including box, ironbark, cypress pine, mallee, buloke, brigalow and belah woodlands/forests and will roost in tree hollows, crevices and under loose bark within these communities (DEC 2005c; DSEWPC 2010n)	There is a high likelihood that this species occurs within the RoW, where suitable habitat occurs (eg Brigalow, riparian vegetation associated with the Dawson River, Calliope River and Mimisa Creek and ironbark and cypress woodland within the Fairview CSG Fields). A <i>Nyctophilus</i> species was identified using anabat technology within the RoW, however it was not possible to positively identify it to species level (Ecologica Consulting, 2010). There are no known roosting and/or breeding places within and directly adjacent to the RoW
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	CB	V	Rainforests, mangroves, Paperbark swamps, wet and dry sclerophyll forest often in gullies and near water	There is a high likelihood that his species forages within the Mainland GTP RoW, however, there are no known roosting and/or breeding places within and directly adjacent to the RoW

Table notes NC Act Status: E = Endangered, V = Vulnerable, S = Special Least Concern; LC = Least Concern; CB = Colonial breeder
 EPBC Act Status: E = Endangered; V = Vulnerable; Mi = Migratory; Ma = Marine
 Source EPBC Act Protected Matters Search Tool 2011; Wildlife Online 2011





Mainland GTP RoW faunal diversity

A complete fauna species list for all taxa identified during recent surveys (within approximately 5 km of the Mainland GTP RoW) is presented in Table 9.11. In total, 319 species, comprised of 22 amphibians, 52 reptiles, 195 birds, and 50 mammals have been detected within and/or adjacent to the Mainland GTP RoW.



Table 9.11 Fauna Species known to occur within the vicinity (<5km) of the Mainland GTP RoW

Scientific name	Common name	NC Act status	EPBC Act status	Source	
				URS 2008	Ecologica Consulting 2010
Amphibians					
<i>Adelotus brevis</i>	Tusked frog	T	-		
<i>Crinia parinsignifera</i>	Beeping froglet	LC	-	-	X
<i>Cyclorana brevipes</i>	Superb collared frog	LC	-	-	X
<i>Cyclorana platycephala</i>	Waterholding frog	LC	-	-	X
<i>Cyclorana verrucosa</i>	Rough collared frog	T	-		
<i>Limnodynastes fletcheri</i>	Long-thumbed frog	LC	-	-	X
<i>Limnodynastes peronii</i>	Striped marsh frog	LC	-	-	X
<i>Limnodynastes salmini</i>	Salmon-striped frog	LC	-	-	X
<i>Limnodynastes tasmaniensis</i>	Spotted marshfrog	LC	-	-	X
<i>Limnodynastes terrareginae</i>	Scarlet-sided pobblebonk	LC	-	-	X
<i>Litoria aloguttata</i>	Striped burrowing frog	LC	-	-	X
<i>Litoria caerulea</i>	Green tree frog	LC	-	-	X
<i>Litoria fallax</i>	Eastern sedgefrog	LC	-	-	X
<i>Litoria inermis</i>	Floodplain frog	LC	-	-	X
<i>Litoria latopalmata</i>	Broad-palmed rocketfrog	LC	-	-	X
<i>Litoria lesueri</i>	Lesueur's frog	LC	-	-	X
<i>Litoria nasuta</i>	Rocket frog	LC	-	-	X
<i>Litoria peroni</i>	Person's tree frog	LC	-	-	X
<i>Litoria rothii</i>	Roth's tree-frog	LC	-	-	X
<i>Litoria rubella</i>	Desert tree frog	LC	-	-	X
<i>Platyplectrum ornatus</i>	Ornate burrowing frog	LC	-	-	X
<i>Pseudophryne</i> sp.	-	LC	-	-	X



Scientific name	Common name	NC Act status	EPBC Act status	Source	
				URS 2008	Ecologica Consulting 2010
<i>Rhinella marinus</i> *	Cane toad	-	KTP	X	X
<i>Uperoleia rugosa</i>	Chubby gungan	LC	-	-	X
Reptiles					
<i>Acanthophis antarticus</i>	Death adder	NT	-		
<i>Amphibolurus burnsii</i>	Burns' dragon	LC	-	-	X
<i>Amphibolurus muricata</i>	Jacky lizard	LC	-	-	X
<i>Amphibolurus nobbi</i>	Nobbi dragon	LC	-	-	X
<i>Antaresia maculosa</i>	Spotted python	LC	-	-	X
<i>Aspidites melanocephalus</i>	Black-headed python	LC	-	-	X
<i>Boiga irregularis</i>	Brown tree snake	LC	-	-	X
<i>Carlia schmelzii</i>	Robust rainbow-skink	LC	-	-	X
<i>Chelodina longicollis</i>	Eastern long-necked turtle	LC	-	-	X
<i>Crenotus robustus</i>	Eastern striped skink	LC	-	-	X
<i>Cryptoblepharus plagiocephalus</i>	Callose-palmed shinning-skink	LC	-	-	X
<i>Cryptoblepharus virgatus</i>	Wall skink	LC	-	X	X
<i>Cryptophis boschmai</i>	Carpentaria snake	LC	-	-	X
<i>Ctenotus robustus</i>	Eastern striped skink	LC	-	-	X
<i>Ctenotus sp.</i>	-	LC	-	-	X
<i>Ctenotus taeniolatus</i>	Copper-tailed skink	LC	-	-	X
<i>Demansia psammophis</i>	Yellow-faced whip snake	LC	-	X	X
<i>Demansia vestigiata</i>	Lesser black whip snake	LC	-	-	X
<i>Dendrelaphis punctulata</i>	Green tree snake	LC	-	-	X
<i>Diporiphora australis</i>	Tommy round-head	LC	-	-	X
<i>Emydura macquarii krefftii</i>	Krefft's turtle	LC	-	-	X



Scientific name	Common name	NC Act status	EPBC Act status	Source	
				URS 2008	Ecologica Consulting 2010
<i>Eulamprus brachysoma</i>	-	LC	-	-	X
<i>Eulamprus martini</i>	Martin's skink	LC	-	-	X
<i>Eulamprus quoyii</i>	Eastern water skink	LC	-	-	X
<i>Eulamprus sp.</i>	-	LC	-	-	X
<i>Eulamprus tenuis</i>	Bar-sided skink	LC	-	-	X
<i>Furina diadema</i>	Red-naped snake	LC	-	-	X
<i>Gehyra catenata</i>	Chain-backed dtella	LC	-	-	X
<i>Gehyra dubia</i>	Dubious dtella	LC	-	-	X
<i>Heteronotia binoei</i>	Bynoe's gecko	LC	-	-	X
<i>Lampropholis delicata</i>	Garden skink	LC	-	-	X
<i>Lampropholis sp.</i>	-	LC	-	-	X
<i>Lerista fragilis</i>	Eastern mulch-slider	LC	-	-	X
<i>Lerista sp.</i>	-	LC	-	-	X
<i>Menetia sp.</i>	-	LC	-	-	X
<i>Morelia spilota</i>	Carpet python	LC	-	-	X
<i>Morethia boulengeri</i>	South-eastern morethia skink	LC	-	-	X
<i>Morethia taeniopleura</i>	North-eastern firetail skink	LC	-	-	X
<i>Oedura ocellata</i>	Ocellated velvet gecko	LC	-	-	X
<i>Oxyuranus scutellatus</i>	Coastal taipan	LC	-	-	X
<i>Paradelma orientalis</i>	Brigalow scaly-foot	V	V	-	X
<i>Physignathus lesueurii</i>	Water dragon	LC	-	-	X
<i>Pogona barbata</i>	Eastern bearded dragon	LC	-	-	X
<i>Pseudonaja sp.</i>	-	LC	-	-	X
<i>Pseudonaja textilis</i>	Eastern brown snake	LC	-	X	X



Scientific name	Common name	NC Act status	EPBC Act status	Source	
				URS 2008	Ecologica Consulting 2010
<i>Rhinoplocephalus nigrescens</i>	Smalled eyed snake	LC	-	-	X
<i>Strophurus taenicauda</i>	Golden-tailed gecko	NT	-	-	X
<i>Tiliqua scincoides</i>	Eastern blue-tongue lizard	LC	-	-	X
<i>Tropidonophis mairii</i>	Freshwater snake	LC	-	-	X
<i>Tympanocryptis lineata</i>	Lined earless dragon	LC	-	-	X
<i>Underwoodisurus milii</i>	Thick-tailed gecko	LC	-	-	X
<i>Varanus tristis</i>	Black-headed monitor	LC	-	-	X
<i>Varanus varius</i>	Lace monitor	LC	-	-	X
Birds					
<i>Acanthagenys rufogularis</i>	Spiny-cheeked honeyeater	LC	-	-	X
<i>Acanthiza apicalis</i>	Inland thornbill	LC	-	-	X
<i>Acanthiza chrysorrhoa</i>	Yellow-rumped thornbill	LC	-	-	X
<i>Acanthiza nana</i>	Yellow thornbill	LC	-	-	X
<i>Acanthiza pusilla</i>	Brown thornbill	LC	-	-	X
<i>Acanthiza reguloides</i>	Buff-rumped thornbill	LC	-	-	X
<i>Accipiter cirrocephalus</i>	Collared sparrowhawk	LC	-	-	X
<i>Accipiter fasciatus</i>	Brown goshawk	LC	-	-	X
<i>Acrocephalus australis</i>	Australian reed-warbler	S	Mi	-	X
<i>Aegotheles cristatus</i>	Australian owlet-nightjar	LC	-	-	X
<i>Alectura lathami</i>	Australian brush-turkey	LC	-	-	X
<i>Alisterus scapularis</i>	Australian king-parrot	LC	-	-	X
<i>Anas castanea</i>	Chestnut teal	LC	-	-	X
<i>Anas gracilis</i>	Grey teal	LC	-	-	X
<i>Anas superciliosa</i>	Pacific black duck	LC	-	X	X



Scientific name	Common name	NC Act status	EPBC Act status	Source	
				URS 2008	Ecologica Consulting 2010
<i>Anhinga novaehollandiae</i>	Australasian darter	LC	-	-	X
<i>Anseranas semipalmata</i>	Magpie goose	LC	-	-	X
<i>Anthus australis</i>	Australian pipit	LC	-	X	X
<i>Aprosmictus erythropterus</i>	Red-winged parrot	LC	-	X	X
<i>Aquila audax</i>	Wedge-tailed eagle	LC	-	X	X
<i>Ardea alba</i>	Great egret	S	Mi/Ma	-	X
<i>Ardea ibis</i>	Cattle egret	S	Mi	-	X
<i>Ardea intermedia</i>	Intermediate egret	LC	-	-	X
<i>Ardea pacifica</i>	White-necked heron	LC	-	X	X
<i>Ardeotis australis</i>	Australian bustard	LC	-	X	X
<i>Artamus cinereus</i>	Black-faced woodswallow	LC	-	-	X
<i>Artamus cyanopterus</i>	Dusky woodswallow	LC	-	-	X
<i>Artamus leucorhynchus</i>	White-breasted woodswallow	LC	-	-	X
<i>Artamus personatus</i>	Masked woodswallow	LC	-	-	X
<i>Aviceda subcristata</i>	Pacific baza	LC	-	-	X
<i>Aythya australis</i>	Hardhead	LC	-	-	X
<i>Burhinus grallarius</i> [#]	Bush stone-curlew	LC	-	-	X
<i>Cacatua galerita</i>	Sulphur-crested cockatoo	LC	-	X	X
<i>Cacatua roseicapilla</i>	Galah	LC	-	-	X
<i>Cacatua sanguinea</i>	Little corella	LC	-	X	X
<i>Cacomantis flabelliformis</i>	Fan-tailed cuckoo	LC	-	X	X
<i>Calyptorhynchus banksii</i>	Red-tailed black-cockatoo	LC	-	X	X
<i>Centropus phasianinus</i>	Pheasant coucal	LC	-	X	X
<i>Ceyx azureus</i>	Azure kingfisher	LC	-	-	X





Scientific name	Common name	NC Act status	EPBC Act status	Source	
				URS 2008	Ecologica Consulting 2010
<i>Chalcites basalis</i>	Horsfield's bronze-cuckoo	LC	-	-	X
<i>Chalcophaps indica</i>	Emerald dove	LC	-	-	X
<i>Chenonetta jubata</i>	Australian wood duck	LC	-	X	X
<i>Cheramoeca leucosterna</i>	White-backed swallow	LC	-	-	X
<i>Cincloramphus cruralis</i>	Brown songlark	LC	-	-	X
<i>Cincloramphus mathewsi</i>	Rufous songlark	LC	-	-	X
<i>Circus approximans</i>	Swamp harrier	LC	-	-	X
<i>Cisticola exilis</i>	Golden-headed cisticola	LC	-	-	X
<i>Climacteris picumnus</i>	Brown treecreeper	LC	-	X	X
<i>Colluricincla harmonica</i>	Grey shrike-thrush	LC	-	-	X
<i>Colluricincla megarhyncha</i>	Little shrike-thrush	LC	-	-	X
<i>Coracina lineata</i>	Barred cuckoo-shrike	LC	-	-	X
<i>Coracina maxima</i>	Ground cuckoo-shrike	LC	-	-	X
<i>Coracina novaehollandiae</i>	Black-faced cuckoo-shrike	LC	-	X	X
<i>Coracina papuensis</i>	White-bellied cuckoo-shrike	LC	-	-	X
<i>Coracina tenuirostris</i>	Cicadabird	LC	-	-	X
<i>Corcorax melanorhamphos</i>	White-winged cough	LC	-	X	X
<i>Corvus bennetti</i>	Little crow	LC	-	-	X
<i>Corvus coronoides</i>	Australian raven	LC	-	X	X
<i>Corvus orru</i>	Torresian crow	LC	-	X	X
<i>Coturnix pectoralis</i>	Stubble quail	LC	-	-	X
<i>Coturnix ypsilophora</i>	Brown quail	LC	-	-	X
<i>Cracticus nigrogularis</i>	Pied butcherbird	LC	-	X	X
<i>Cracticus tibicen</i>	Australian magpie	LC	-	X	X



Scientific name	Common name	NC Act status	EPBC Act status	Source	
				URS 2008	Ecologica Consulting 2010
<i>Cracticus torquatus</i>	Grey butcherbird	LC	-	X	X
<i>Cygnus atratus</i>	Black swan	LC	-	-	X
<i>Dacelo leachii</i>	Blue-winged kookaburra	LC	-	-	X
<i>Dacelo novaeguineae</i>	Laughing kookaburra	LC	-	X	X
<i>Daphoenositta chrysoptera</i>	Varied sittella	LC	-	X	X
<i>Dendrocygna eytoni</i>	Plumed whistling-duck	LC	-	-	X
<i>Dicaeum hirundinaceum</i>	Mistletoebird	LC	-	-	X
<i>Dicrurus bracteatus</i>	Spangled drongo	LC	-	-	X
<i>Dromaius novaehollandiae</i>	Emu	LC	-	-	X
<i>Egretta garzetta</i>	Little egret	LC	-	-	X
<i>Egretta novaehollandiae</i>	White-faced heron	LC	-	-	X
<i>Entomyzon cyanotis</i>	Blue-faced honeyeater	LC	-	X	X
<i>Eopsaltria australis</i>	Eastern yellow robin	LC	-	-	X
<i>Ephippiorhynchus asiaticus</i>	Black-necked stork	NT	-	-	X
<i>Eudynamys orientalis</i>	Eastern koel	LC	-	-	X
<i>Eurostopodus mystacalis</i>	White-throated nightjar	LC	-	-	X
<i>Eurystomus orientalis</i>	Dollarbird	LC	-	-	X
<i>Excalfactoria chinensis</i>	King quail	LC	-	-	X
<i>Falco berigora</i>	Brown falcon	LC	-	X	X
<i>Falco cenchroides</i>	Nankeen kestrel	LC	-	X	X
<i>Falco longipennis</i>	Australian hobby	LC	-	X	X
<i>Fulica atra</i>	Eurasian coot	LC	-	-	X
<i>Geopelia cuneata</i>	Diamond dove	LC	-	X	X
<i>Geopelia humeralis</i>	Bar-shouldered dove	LC	-	X	X





Scientific name	Common name	NC Act status	EPBC Act status	Source	
				URS 2008	Ecologica Consulting 2010
<i>Geopelia striata</i>	Peaceful dove	LC	-	X	X
<i>Geophaps scripta scripta</i>	Squatter pigeon	V	V	X	X
<i>Gerygone albogularis</i>	White-throated gerygone	LC	-	X	X
<i>Gerygone fusca</i>	Western gerygone	LC	-	X	X
<i>Gerygone mouki</i>	Brown gerygone	LC	-	-	X
<i>Gerygone palpebrosa</i>	Fairy gerygone	LC	-	-	X
<i>Glossopsitta pusilla</i>	Little lorikeet	LC	-	-	X
<i>Grallina cyanoleuca</i>	Magpie-lark	LC	-	X	X
<i>Grus rubicunda</i>	Brolga	LC	-	X	X
<i>Haliaeetus leucogaster</i>	White-bellied sea-eagle	S	Mi/Ma	X	X
<i>Haliastur sphenurus</i>	Whistling kite	LC	-	X	X
<i>Hamirostra melanosternon</i>	Black-breasted buzzard	LC	-	-	X
<i>Hieraaetus morphnoides</i>	Little eagle	LC	-	-	X
<i>Hirundo neoxena</i>	Welcome swallow	LC	-	X	X
<i>Lalage leucomela</i>	Varied triller	LC	-	-	X
<i>Lalage sueurii</i>	White-winged triller	LC	-	-	X
<i>Lichenostomus chrysops</i>	Yellow-faced honeyeater	LC	-	-	X
<i>Lichenostomus fuscus</i>	Fuscous honeyeater	LC	-	-	X
<i>Lichenostomus leucotis</i>	White-eared honeyeater	LC	-	-	X
<i>Lichenostomus melanops</i>	Yellow-tufted honeyeater	LC	-	-	X
<i>Lichenostomus penicillatus</i>	White-plumed honeyeater	LC	-	-	X
<i>Lichenostomus virescens</i>	Singing honeyeater	LC	-	-	X
<i>Lichmera indistincta</i>	Brown honeyeater	LC	-	X	X
<i>Lonchura castaneothorax</i>	Chestnut-breasted mannikin	LC	-	-	X





Scientific name	Common name	NC Act status	EPBC Act status	Source	
				URS 2008	Ecologica Consulting 2010
<i>Lophoictinia isura</i>	Square-tailed kite	NT	-	-	X
<i>Malurus cyaneus</i>	Superb fairy-wren	LC	-	-	X
<i>Malurus lamberti</i>	Variegated fairy-wren	LC	-	-	X
<i>Malurus melanocephalus</i>	Red-backed fairy-wren	LC	-	X	X
<i>Manorina melanocephala</i>	Noisy miner	LC	-	X	X
<i>Megalurus gramineus</i>	Little grassbird	LC	-	-	X
<i>Megalurus timoriensis</i>	Tawny grassbird	LC	-	-	X
<i>Meliphaga lewinii</i>	Lewin's honeyeater	LC	-	-	X
<i>Melithreptus albogularis</i>	White-throated honeyeater	LC	-	X	X
<i>Melithreptus albogularis</i>	White-throated honeyeater	LC	-	X	X
<i>Melithreptus lunatus</i>	White-naped honeyeater	LC	-	-	X
<i>Merops ornatus</i>	Rainbow bee-eater	S	Mi/Ma	X	X
<i>Microcarbo melanoleucos</i>	Little pied cormorant	LC	-	-	X
<i>Microeca fascinans</i>	Jacky winter	LC	-	-	X
<i>Milvus migrans</i>	Black kite	LC	-	-	X
<i>Mirafrja javanica</i>	Horsfield's bushlark	LC	-	X	X
<i>Myiagra cyanoleuca</i>	Satin flycatcher	S	Mi/Ma	-	X
<i>Myiagra inquieta</i>	Restless flycatcher	LC	-	-	X
<i>Myiagra rubecula</i>	Leaden flycatcher	LC	-	-	X
<i>Myzomela sanguinolenta</i>	Scarlet honeyeater	LC	-	-	X
<i>Neochmia modesta</i>	Plum-headed finch	LC	-	-	X
<i>Nettapus coromandelianus</i>	Cotton pygmy-goose	NT	-	-	X
<i>Nettapus pulchellus</i>	Green pygmy-goose	LC	-	-	X
<i>Ninox connivens</i>	Barking owl	LC	-	-	X





Scientific name	Common name	NC Act status	EPBC Act status	Source	
				URS 2008	Ecologica Consulting 2010
<i>Ninox novaeseelandiae</i>	Southern boobook	LC	-	-	X
<i>Ninox strenua</i>	Powerful owl	V	-	-	X
<i>Numenius madagascariensis</i>	Eastern curlew	NT	Mi/Ma	-	X
<i>Numenius minutus</i>	Little curlew	LC	Mi/Ma	-	X
<i>Numenius phaeopus</i> [#]	Whimbrel	S	Mi/Ma	-	X
<i>Nycticorax caledonicus</i>	Nankeen night-heron	LC	-	-	X
<i>Nymphicus hollandicus</i>	Cockatiel	LC	-	X	X
<i>Ocyphaps lophotes</i>	Crested pigeon	LC	-	X	X
<i>Oriolus sagittatus</i>	Olive-backed oriole	LC	-	-	X
<i>Pachycephala pectoralis</i>	Golden whistler	LC	-	X	X
<i>Pachycephala rufiventris</i>	Rufous whistler	LC	-	-	X
<i>Pardalotus striatus</i>	Striated pardalote	LC	-	X	X
<i>Passer domesticus</i> [*]	House sparrow	-	-	-	X
<i>Pavo cristatus</i> [*]	Indian peafowl	-	-	X	
<i>Petrochelidon ariel</i>	Fairy martin	LC	-	-	X
<i>Petrochelidon nigricans</i>	Tree martin	LC	-	-	X
<i>Petroica rosea</i>	Rose robin	LC	-	X	X
<i>Phalacrocorax carbo</i>	Great cormorant	LC	-	-	X
<i>Phalacrocorax sulcirostris</i>	Little black cormorant	LC	-	-	X
<i>Phalacrocorax varius</i>	Pied cormorant	LC	-	X	X
<i>Phaps chalcoptera</i>	Common bronzewing	LC	-	-	X
<i>Philemon citreogularis</i>	Little friarbird	LC	-	-	X
<i>Philemon corniculatus</i>	Noisy friarbird	LC	-	X	X
<i>Platalea regia</i>	Royal spoonbill	LC	-	X	X



Scientific name	Common name	NC Act status	EPBC Act status	Source	
				URS 2008	Ecologica Consulting 2010
<i>Platycercus adscitus</i>	Pale-headed rosella	LC	-	X	X
<i>Plectorhyncha lanceolata</i>	Striped honeyeater	LC	-	-	X
<i>Podargus strigoides</i>	Tawny frogmouth	LC	-	-	X
<i>Podiceps cristatus</i>	Great crested grebe	LC	-	-	X
<i>Poliiocephalus poliocephalus</i>	Hoary-headed grebe	LC	-	-	X
<i>Pomatostomus temporalis</i>	Grey-crowned babbler	LC	-	-	X
<i>Porphyrio porphyrio</i>	Purple swamphen	LC	-	-	X
<i>Psophodes olivaceus</i>	Eastern whipbird	LC	-	-	X
<i>Ptilonorhynchus maculatus</i>	Spotted bowerbird	LC	-	-	X
<i>Rhipidura albiscapa</i>	Grey fantail	LC	-	X	X
<i>Rhipidura leucophrys</i>	Willy wagtail	LC	-	X	X
<i>Scythrops novaehollandiae</i>	Channel-billed cuckoo	S	Ma	-	X
<i>Sericornis frontalis</i>	White-browed scrubwren	LC	-	-	X
<i>Smicromis brevirostris</i>	Weebill	LC	-	X	X
<i>Sphecotheres vieilloti</i>	Australasian figbird	LC	-	-	X
<i>Sterna caspia</i>	Caspian tern	S	Mi/Ma	-	X
<i>Strepera fuliginosa</i>	Pied currawong	LC	-	X	X
<i>Struthidea cinerea</i>	Apostlebird	LC	-	X	X
<i>Sturnus vulgaris</i>	Common starling [#]	-	-	-	X
<i>Tachybaptus novaehollandiae</i>	Australasian grebe	LC	-	X	X
<i>Taeniopygia bichenovii</i>	Double-barred finch	LC	-	X	X
<i>Taeniopygia guttata</i>	Zebra finch	LC	-	-	X
<i>Threskiornis molucca</i>	Australian white ibis	LC	-	-	X
<i>Threskiornis spinicollis</i>	Straw-necked ibis	LC	-	-	X





Scientific name	Common name	NC Act status	EPBC Act status	Source	
				URS 2008	Ecologica Consulting 2010
<i>Todiramphus chloris</i>	Collared kingfisher	LC	-	-	X
<i>Todiramphus macleayii</i>	Forest kingfisher	LC	-	X	X
<i>Todiramphus sanctus</i>	Sacred kingfisher	LC	-	-	X
<i>Trichoglossus chlorolepidotus</i>	Scaly-breasted lorikeet	LC	-	-	X
<i>Trichoglossus haematodus moluccanus</i>	Rainbow lorikeet	LC	-	X	X
<i>Turnix sp.</i>	-	LC	-	-	X
<i>Tyto alba</i>	Barn owl	LC	-	-	X
<i>Tyto capensis</i>	Grass owl	LC	-	-	X
<i>Tyto novaehollandiae</i>	Masked owl	LC	-	-	X
<i>Vanellus miles</i> [#]	Masked lapwing	LC	-	-	X
<i>Vanellus tricolor</i> [#]	Banded lapwing	LC	-	-	X
<i>Zosterops lateralis</i>	Silvereye	LC	-	-	X
Mammals					
<i>Aepyprymnus rufescens</i>	Rufous bettong	LC	-	-	X
<i>Bos taurus</i> [*]	Domestic cattle	-	-	X	X
<i>Canis lupus dingo</i> [*]	Dingo	-	-	X	X
<i>Canis lupus familiaris</i> [*]	Dog	-	-	-	X
<i>Chaerephon jobensis</i>	Northern mastiff-bat	LC/CB	-	-	X
<i>Chalinolobus dwyeri</i>	Large-eared pied bat	V/CB	V	-	X
<i>Chalinolobus gouldii</i>	Gould's wattled bat	LC/CB	-	-	X
<i>Chalinolobus morio</i>	Chocolate wattled bat	LC/CB	-	-	X
<i>Chalinolobus nigrogriseus</i>	Hoary bat	LC/CB	-	-	X
<i>Chalinolobus picatus</i>	Little pied bat	NT/CB	-	-	X
<i>Equus caballus</i> [*]	Domestic horse	-	-	X	X



Scientific name	Common name	NC Act status	EPBC Act status	Source	
				URS 2008	Ecologica Consulting 2010
<i>Felis catus</i> *	Feral cat	-	-	-	X
<i>Hydromys chrysogaster</i>	False water rat	LC	-	X	X
<i>Isodon macrourus</i>	Northern brown bandicoot	LC	-	-	X
<i>Lepus europaeus</i> *	European brown hare	-	-	-	X
<i>Lophoictinia isura</i>	Black-necked stork	-	-	-	
<i>Macropus dorsalis</i>	Black-striped wallaby	LC	-	-	X
<i>Macropus giganteus</i>	Eastern grey kangaroo	LC	-	X	X
<i>Macropus parryi</i>	Whiptail wallaby	LC	-	X	X
<i>Macropus robustus</i>	Common wallaroo	LC	-	-	X
<i>Macropus rufogriseus</i>	Red-necked wallaby	LC	-	X	X
<i>Miniopterus australis</i>	Little bent-winged bat	LC/CB	-	-	X
<i>Miniopterus orianae oceanensis</i>	Eastern bent-wing bat	LC/CB	-	-	X
<i>Mormopterus beccarii</i>	Beccari's mastiff-bat	LC/CB	-	-	X
<i>Mormopterus eleryi</i>	Hairy-nosed freetail bat	LC/CB	-	-	X
<i>Mormopterus ridei</i>	Eastern free-tailed bat	LC/CB	-	-	X
<i>Mormopterus sp.</i>	-	LC/CB	-	-	X
<i>Mus musculus</i> *	House mouse	-	-	-	X
<i>Nyctophilus sp.</i>	Unknown long-eared bat	LC/CB	-	-	(X)
<i>Ninox stenua</i>	Powerful owl	-	-	-	
<i>Ornithorhynchus anatinus</i>	Platypus	S/lc	-	-	X
<i>Oryctolagus cuniculus</i> *	European rabbit	-	-	X	X
<i>Perameles nasuta</i>	Long-nosed bandicoot	LC	-	-	X
<i>Petauroides volans</i>	Greater glider	LC	-	-	X
<i>Petaurus australis</i>	Yellow-bellied glider	LC	-	-	X





Scientific name	Common name	NC Act status	EPBC Act status	Source	
				URS 2008	Ecologica Consulting 2010
<i>Petaurus breviceps</i>	Sugar glider	LC	-	-	X
<i>Petaurus norfolcensis</i>	Squirrel glider	LC	-	-	X
<i>Rattus sp.</i>	Rat	LC	-	-	X
<i>Saccolaimus flaviventris</i>	Yellow-bellied sheath-tailed bat	LC/CB	-	-	X
<i>Scoteanax rueppellii</i>	Greater broad-nosed bat	LC/CB	-	-	X
<i>Scotorepens balstoni</i>	Western broad-nosed bat	LC/CB	-	-	X
<i>Scotorepens greyii</i>	Little broad-nosed bat	LC/CB	-	-	X
<i>Sminthopsis macroura</i>	Stripe-faced dunnart	LC	-	-	X
<i>Sus scrofa</i> *	Feral pig	-	-	X	X
<i>Tachyglossus aculeatus</i>	Echidna	S/lc	-	X	X
<i>Tadarida australis</i>	White-striped free-tailed bat	LC/CB	-	-	X
<i>Taphozous troughtoni</i>	Troughton's sheath-tail bat	LC/CB	-	-	X
<i>Trichosurus vulpecula</i>	Common brushtail possum	LC	-	-	X
<i>Vespadelus baverstocki</i>	Inland forest bat	LC/CB	-	-	X
<i>Vespadelus troughtoni</i>	Eastern cave bat	LC/CB	-	-	X
<i>Vulpes vulpes</i> *	European red fox	-	-	X	X
<i>Wallabia bicolor</i>	Swamp wallaby	LC	-	X	X

Table notes = species has been detected, however not necessarily within the RoW; * = exotic species; # = shorebird species; () = species was unreliably identified due to poor quality Anabat data or indistinguishable similarity between species
 NC Act Status: E = Endangered, V = Vulnerable, T = Threatened NT = Near Threatened; S = Special Least Concern; LC = Least Concern; I = Introduced; lc = Iconic; CB = Colonial breeding species
 EPBC Act Status: E = Endangered; V = Vulnerable; Mi = Migratory; Ma = Marine; KTP = Key Threatening Process
 Source EPBC Act Protected Matters Search Tool 2011; Wildlife Online 2011

Amphibians

Suitable habitat occurs within the Mainland GTP RoW for a high diversity of amphibians. In total 22 amphibian species have been identified from habitats within and adjacent to the Mainland GTP RoW. This represents approximately 47% of the amphibian species known from the Fitzroy Natural Resource Management Area.

The species richness can be attributed in part, to rainfall prior to, and during the survey conducted by Ecologica Consulting in 2010, with frogs actively calling and moving during both day and night periods. Frog spawn was present at most wetlands encountered along the Mainland GTP RoW.

The Spotted marshfrog (*Limnodynastes tasmaniensis*) and Green tree frog (*Litoria caerulea*) were the most common species encountered along the Mainland GTP RoW.

The highest diversity of frogs were recorded from palustrine and riverine wetlands (ie Bells Creek and Baffle Creek) within and adjacent the Mainland GTP RoW, and on adjacent major access tracks/roads.

Other species including Green tree frog and Northern pobblebonk (*Limnodynastes terraereginae*) were identified within terrestrial habitats of the Mainland GTP RoW (eg under logs, within soil banks). One species, namely *Cyclorana platycephala* (Waterholding frog) was located near Biloela which is 200 km to the north of its current known distribution.

Targeted searches for conservation significant amphibian species have not resulted in their detection. However, *Adelotus brevis* (Tusked frog) and *Cyclorana verrucosa* (Rough collared frog), both of which are listed as threatened under the NC Act (vulnerable and near threatened, respectively), are known from habitats contiguous with the Mainland GTP RoW, and are thus considered to have a high likelihood of occurrence (Queensland Museum 2011).

Rhinella marina (Cane toads) were recorded at a number of locations along the Mainland GTP RoW. Cane toads are listed under the provisions of the EPBC Act as a Key Threatening Process.

Reptiles

Fifty-two (52) species of reptiles have been recorded within or adjacent to the Mainland GTP RoW during field investigations (URS 2008; Ecologica 2010). This represents approximately 26% of the reptiles known from the Fitzroy Natural Resource Management Area.

The low diversity of reptile species and the absence of specialist species (eg fossorial snakes and pygopods) can be attributed to the cryptic nature snakes, the timing and frequency of the surveys and the survey techniques adopted during surveys.

Most of the reptilian species identified are considered common and widespread (ie listed as least concern under the provision of the NC Act), however most species recorded were represented by only one individual. Two threatened species, *Paradelma orientalis* (Brigalow scaly foot) (EPBC Act and NC Act listed vulnerable) and the *Strophurus taenicauda* (Golden tailed gecko) (NC Act near threatened) were identified from habitats within and adjacent to the Mainland GTP RoW.

The highest diversity of reptiles was predominately associated with the remnant patches of Brigalow, and rock ledges and outcrops within Eucalypt woodlands. A number of reptile species were also observed within the microhabitats (fallen timber) retained within the Jemena Gas Pipeline corridor, especially through the Expedition Range.

The most commonly encountered reptiles were terrestrial, particularly skinks. These species include *Ctenotus taeniolatus* (Copper-tailed skink), *Carlia* sp., *Menetia* sp. and *Lampropholis* spp. Semi-arboreal *Cryptoblepharus* spp. were also commonly encountered within the Eucalypt woodlands throughout the Mainland GTP RoW. *Lerista fragilis* (Eastern mulch-slider) was also commonly encountered under rocks and logs where there was a loose area of soil.

Additional skinks recorded include the *Tiliqua scincoides* (Eastern blue-tongue lizard), *Morethia* spp., *Carlia schmeltzii* (Robust rainbow-skink) and *Ctenotus robustus* (Eastern striped skink). *Eulamprus* spp. were regularly observed in rocky areas, including Baffle Creek and Expedition Range (south of the Dawson River).

Pogona barbata (Eastern bearded dragon) was encountered within the vicinity of the Fairview CSG fields whilst six additional dragon species were positively identified from habitats throughout the project area. These included the *Amphibolurus burnsi* (Burn's dragon) *Amphibolurus muricata* (Jacky lizard), *Amphibolurus nobbi* (Nobbi dragon), *Diporiphora australis* (Tommy roundhead dragon), *Tympanocryptis lineata* (Lined earless dragon) and *Physignathus lesueurii* (Water dragon).

Only one pygopod, the Brigalow scaly-foot was identified from regrowth Brigalow near Pyramid Hill.

Two varanids, *Varanus tristis* (Black-headed monitor) and *Varanus varanus* (Lace monitor) were observed during the field surveys, while 14 snake species were observed during the survey periods with the most abundant species being *Tropidonophis mairii* (Freshwater snake). The Freshwater snake, *Dendrelaphis punctulata* (Green tree snake) and *Boiga irregularis* (Brown tree snake) are members of the Colubridae family (non-venomous or rear-fanged venomous species), which dominates the snake assemblages in all other continents other than Australia.

Three species of python, the *Morelia spilota* (Carpet python), *Antaresia maculosa* (Spotted python) and *Aspidites melanocephalus* (Black-headed python) were also encountered during the field surveys. It should be noted that the near threatened (NC Act) *Aspidites ramsayi* (Woma) may also occur, utilising habitats within and adjacent the Mainland GTP RoW.

The main group of snakes encountered during the field activities were Elapids (ie front fanged venomous snakes), which is the most diverse group of snakes in Australia. The *Cryptophis boschmai* (Carpentaria snake) and the *Rhinoplocephalus nigrescens* (Small eyed snake) were frequently encountered under logs and rocks in the Brigalow and woodland communities near the Dawson River. Other species encountered included the *Demansia vestigiata* (Lesser black whip snake), *Furina diadema*, (Red-naped snake) *Pseudonaja textilis* (Eastern brown snake) and *Oxyuranus scutellatus* (Coastal taipan).

It should be noted that six unidentified elapid snake species were encountered, with the majority encountered under woody debris within Brigalow communities.

No conservation significant snake species were recorded, however there is the potential for such species to inhabit areas within and adjacent to the Mainland GTP RoW. *Denisonia maculata* (Ornamental snake) and *Furina dunmalli* (Dunmall's snake) (both listed as vulnerable under the provision of the NC Act and EPBC Act) are considered to have a high likelihood of occurrence within the Mainland GTP RoW. There is also the potential for the *Acanthophis antarcticus* (Death adder) (listed as near threatened under the NC Act) to occur due to the presence of potentially suitable habitat.

Freshwater turtles were observed at a number of creeks, including Hutton Creek and the Calliope River. Two species were positively identified as *Chelodina longicollis* (Eastern long-necked turtle) and *Emydura macquarii krefftii* (Krefft's turtle). The Eastern long-necked turtle was encountered following significant rainfalls prior to and during the 2010 survey period crossing the country roads around Biloela (Ecologica Consulting, 2010), whilst Krefft's turtle was identified at Hutton Creek.

Where there is permanent water, it is likely that freshwater turtles inhabit a number of watercourses that are intercepted by the Mainland GTP RoW. This includes conservation significant species such as the vulnerable (EPBC Act/NC Act) *Rheodytes leukops* (Fitzroy River turtle) which is known to inhabit the Dawson River directly downstream of the second RoW crossing (ie Baralaba Weir). *Eiseya albagula* (White-throated snapping turtle), which is a DERM Back on Track Species, is also known from Hutton Creek, directly downstream of the project area.

Birds

During field surveys, 195 bird species were identified from habitats within and adjacent the Mainland GTP RoW. This represents approximately 43% of the birds known from the Fitzroy Natural Resource Management Area.

The species richness observed is to be expected and is a reflection of the diversity of habitat types present within the area, including open eucalypt woodlands and forests, riparian habitats, open grasslands as well as freshwater and intertidal wetlands.

The highest bird diversity was associated with Brigalow, riparian and open Eucalypt woodland communities within the project area. The distribution and variation within the avian population can be attributed to a range of factors including:

- Habitat type and structure
- Degree of disturbance
- Sedentary nature of some species
- Localised migration for breeding purpose (summer migration species include Cuckoos, Plumed whistling ducks, Satin flycatcher and Spangled drongo)
- To exploit unpredictable food resources (such as Honeyeaters, Welcome swallows)

The most common species encountered were more disturbance tolerant species such as *Ocyphaps lophotes* (Crested pigeon), *Grallina cyanoleuca* (Magpie-lark), *Strepera fuliginosa* (Pied-currawong), *Corvus orru* (Torresian crow) and *Corvus coronoides* (Australian raven). These species were present throughout the majority of the Mainland GTP RoW. Other species observed in high abundance included the *Aprosmictus erythropterus* (Red-winged parrot), *Cacatua galerita* (Sulphur crested cockatoo), *Taeniopygia bichenovii* (Double-barred finch), *Nymphicus hollandicus* (Cockatiel), *Cacatua roseicapilla* (Galah) and *Coturnix ypsilophora* (Brown quail).

Fourteen (14) raptor species were recorded, with the *Aquila audax* (Wedge-tailed eagle), *Falco berigora* (Brown falcon), *Falco cenchroides* (Nankeen kestrel) and *Milvus sphrenurus* (Whistling kite) recorded as being the most common throughout the project area.

Five species of owl plus two species of nightjar were identified from the GTP RoW. The highest density of owls was in the Callide Range and Inverness Road area where four species of owl were observed or heard (*Ninox novaeseelandiae* (Southern boobook), *Tyto capensis* (Grass owl), *Tyto novaehollandiae* (Masked owl) and *Tyto alba* (Barn owl)), suggesting availability of plentiful food resources (ie arboreal and ground dwelling mammals). *Ninox strenua* (Powerful owl) and *Ninox connivens* (Barking owl) were recorded from the Aldoga and Mount Larcom areas.

A large number of waterbirds were also present but were generally restricted to dams and wetlands within close proximity to the Mainland GTP RoW or along major access routes. However, some species such as *Anas superciliosa* (Pacific black duck), *Chenonetta jubata* (Australian wood duck), *Egretta* spp. (Egrets) and *Ardea* spp. (Herons) may occur throughout the Mainland GTP RoW.

As indicated in Table 9.10 and Table 9.11, five conservation significant species have been identified from habitats within and adjacent to the Mainland GTP RoW, including *Geophaps scripta scripta* (Squatter pigeon), *Ninox strenua* (Powerful owl), *Lophoictinia isura* (Square-tailed kite), *Ephippiorhynchus asiaticus* (Black-necked stork).

Mammals

During field surveys, 40 native mammal species were identified within and adjacent to the Mainland GTP RoW. This represents approximately 33% of the mammal species known from the Fitzroy Natural Resource Management Area. In addition, ten introduced species were also identified from the GTP RoW.

The majority of the species identified within the Mainland GTP RoW are least concern (NC Act), common, and widespread within their respective distributions. However, two threatened bat species were identified along Baffle Creek, namely the vulnerable (EPBC Act or NC Act) *Chalinolobus dwyeri* (Large-eared pied bat), and *Chalinolobus picatus* (Little pied bat) which is listed as near threatened under the provisions of the NC Act.

Nineteen (19) species of microbats were positively identified from the GTP RoW, while an additional two species could not be positively identified. In addition to the two conservation significant bats recorded, there is the potential for other significant bat species to occur within the Mainland GTP RoW. This includes the *Nyctophilus corbeni* (South-eastern long-eared bat) (ie a *Nyctophilus* species was recorded within the Mainland GTP RoW, however the echolocation data recorded was not tractable to analysis – This species will require positive identification through trapping methodology).

A major factor influencing the distribution and abundance of bats within the Mainland GTP RoW is the abundance of roost sites within the local area. Within forest areas, where there is a large choice of roost sites available, bats may use several roost areas regularly. However, cave dwelling species may be more limited in the number of roosts available.

The bat species that have been identified within the Mainland GTP RoW include hollow-dependent species (ie *Vespadelus baverstocki* (Inland forest bat), *Scotorepens greyii* (Little broad-nosed bat), *Scotorepens balstoni* (Western broad-nosed bat), *Chalinolobus nigrogriseus* (Hoary wattled bat) and *Chalinolobus gouldii* (Gould's wattled bat)), in addition to those which roost in caves, under overhangs and in rocky outcrops (ie Large-eared pied bat, *Vespadelus troughtoni* (Eastern cave bat), *Miniopterus orianae oceanensis* (Eastern bent-wing bat) and *Taphozous troughtoni* (Troughton's sheath-tailed bat)). The Little pied bat and the *Chalinolobus morio* (Chocolate wattled bat) are known to roost in both caves and tree hollows.

Bats were recorded in high abundance near Baffle Creek and Expedition Range. Other areas where bats were identified, included Calliope and Callide Range (URS 2009). These areas had a high diversity of microhabitats which would support bats, including caves, overhangs, rocky outcrops, hollow bearing trees and foraging habitat. Scat and hair analysis also identified the use of Baffle Creek cliffs and rocky outcrops in Expedition Range by microbats (Ecologica Consulting, 2010).

Megabat species such as the *Pteropus alecto* (Black flying fox), *Pteropus poliocephalus* (Grey-headed flying fox) and *Pteropus scapulatus* (Little red flying fox) were not observed during the recent surveys due to restrictions on nocturnal surveys (Ecologica Consulting, 2010). These species are known from the Port Curtis locale and are likely to forage within and adjacent the Mainland GTP RoW. No flying fox camps are known within close proximity to the Mainland GTP RoW.

No *Phascolarctos cinereus* (Koalas) were observed during surveys of the Mainland GTP RoW. However the Callide, Calliope, Dawson and Expedition Ranges are mapped as suitable habitat and potential dispersment corridors (Koala Foundation, date unknown).

It is important to note that the GTP RoW is located within District C as described in the *Nature Conservation (Koala) Conservation Plan 2006 and Management Program 2006-2016*. Within this district there is evidence of Koala population decline. However, Koalas are classified as being of special least concern wildlife under the provisions of the NC Act due to a generally lower perceived threat to their survival (EPA 2006). This is despite a portion of the area being within the SEQ bioregion, in which Koalas are listed as vulnerable under the provisions of the NC Act.

Discussions with landholders indicate that Koala's had not been seen in the Arcadia Valley area in the last 5 years.

Other mammalian species of significance included the *Ornithorhynchus anatinus* (Platypus) which is known to inhabit Hutton Creek and the *Tachyglossus aculeatus* (Echidna) which was identified from a number of habitats within and adjacent the project area. In addition, the *Dasyurus hallucatus* (Northern quoll) (NC Act near threatened; EPBC Act vulnerable) and *Taphozous australis* (Coastal sheathtail bat) (NC Act vulnerable) have been recorded within habitats similar to those intersected by the Mainland GTP RoW, and are thus considered to have a high likelihood of occurrence.

Macropods were commonly recorded along the Mainland GTP RoW, and include the *Macropus giganteus* (Eastern grey kangaroo), *Macropus rufogriseus* (Red-necked wallaby), Swamp wallaby (*Wallabia bicolor*) and Rufous bettong (*Aepyprymnus rufescens*). The *Macropus robustus* (Common wallaroo) and *Macropus dorsalis* (Black-striped wallaby) were also present within the Mainland GTP RoW (predominately within the vicinity of the Fairview CSG area). Towards the more coastal regions of the Mainland GTP RoW, macropod species such as *Macropus agilis* (Agile wallaby) and *Macropus parryi* (Whiptail wallaby) were observed.

It should be noted that *Petrogale herberti* (Herbert's rock Wallaby) (a BAAM priority species in the South-east Queensland Bioregion) is known to inhabit areas of the Expedition Range and Callide Range. However this species has not been observed during the survey periods.

Four species of gliders have been identified from the project area, including the *Petaurus australis* (Yellow-bellied glider), *Petauroides volans* (Greater glider), *Petaurus breviceps* (Sugar glider) and *Petaurus norfolcensis* (Squirrel glider). All of these arboreal species are hollow-dependent, thus the age of the woodlands within the GTP RoW would influence local distribution and abundance.

Key glider habitat was identified in close proximity to the Mainland GTP RoW and is associated with the large habitat trees within the Inverness Road corridor. These species are likely to disperse to adjoining habitats in the Calliope Range. Despite the limited nocturnal surveys, gliders were also identified from habitats in Expedition Range, Calliope Range, the Dawson River near Lonesome National Park and a Queensland blue gum woodland adjacent the Burnett Highway.

As trapping was not undertaken during the 2010 survey period, small ground-dwelling fauna were rarely encountered (Ecologica Consulting, 2010). However, based on scat analysis and diggings, a number of ground dwelling mammals were identified from habitats within the corridor, namely *Sminthopsis macroura* (Striped-faced dunnart), Northern brown bandicoot (*Isoodon macrourus*), Long-nosed bandicoot (*Perameles nasuta*) and an unidentified rat (*Rattus* sp.).

Hydromys chrysogaster (Water rat) was also identified from a drainage line to the north of Baffle Creek.

Exotic/pest mammal species observed within the Mainland GTP RoW include *Mus musculus* (House mouse), *Felis catus* (Feral cat), *Oryctolagus cuniculus* (European rabbit), *Lepus europaeus* (European brown hare), *Sus scrofa* (Feral pig), *Canis familiaris* (Feral dog) and *Canis lupus dingo* (Dingo).

Pests of National and State significance

A review of the EPBC Act Protected Matters databases (DSEWPC, 2011) identified five pest species, as potentially occurring within 5km of the Mainland GTP RoW, namely:

- *Capra hircus* (Goat)
- *Felis catus* (Feral cat)
- *Oryctolagus cuniculus* (European rabbit)
- *Sus scrofa* (Feral pig)
- *Vulpes vulpes* (Red fox)

Three of these pest species were detected during field surveys within the vicinity of the RoW, namely Red fox, European rabbit and Feral cat. Both of these species are also declared under the LP Act as a Class 2 pest³.

Table 9.12 outlines EPBC Act and LP Act declared pest species detected within, or within the vicinity of the Mainland GTP RoW during field investigations.

Table 9.12 Pest species identified within or adjacent to the Mainland GTP RoW

Scientific name	Common name	LP Act class	EPBC Act class	EPBC Act threat abatement plan
<i>Canis familiaris dingo</i>	Dingo	2	-	-
<i>Felis catus</i>	Feral cat	2	Invasive	-
<i>Oryctolagus cuniculus</i>	European rabbit	2	Invasive	-
<i>Rhinella marina</i>	Cane toad	-	Key threatening process	Draft*
<i>Sus scrofa</i>	Feral pig	2	-	-
<i>Vulpes vulpes</i>	Red fox	2	Invasive	-

Table notes *Draft as at March 2011
Source EPBC Act Protected Matters Search Tool; DEWHA 2008;

3 There are three classes of declared pests under the LP Act:

Class 1: is not commonly present in Queensland, and if introduced would cause an adverse economic, environmental or social impact. Class 1 pests established in Queensland are subject to eradication from the state. Landowners must take reasonable steps to keep land free of Class 1 pests

Class 2: is established in Queensland and has, or could have, a substantial adverse economic, environmental or social impact. Management of these pests requires coordination and they are subject to programs led by local government, community or landowners. Landowners must take reasonable steps to keep land free of Class 2 pests

Class 3: is established in Queensland and has, or could have, an adverse economic, environmental or social impact. Landholders are not required to control Class 3 pests unless their land is in or adjacent to an environmentally significant area

An additional six introduced fauna species, not listed under the provisions of the LP Act, or identified as a threatening process under the provisions of the EPBC Act, were detected within, or adjacent to the Mainland GTP RoW during fauna surveys. These species consist of the *Passer domesticus* (House sparrow), *Pavo cristatus* (Indian peafowl), *Bos taurus* (Domestic cattle), *Equus caballus* (Domestic horse), *Lepus europaeus* (European brown hare) and *Mus musculus* (House mouse).

9.3.5 Habitat Values

The Mainland GTP RoW encompasses an area of approximately 1,575 ha, and intersects a diverse array of landscapes, and terrestrial and aquatic habitat types. As a result, the Mainland GTP RoW is rich in biodiversity.

A large portion of the Mainland GTP RoW has been cleared for agricultural activities (ie grazing and cropping). Notwithstanding, the Mainland GTP RoW intersects areas of remnant and native vegetation, including areas which are considered unsuitable for agricultural use. The predominant habitat types identified within the Mainland GTP RoW include dry sclerophyll forests on floodplains, undulating granite and metamorphic hills; sandstone cliffs; Brigalow; open grasslands; riverine/riparian communities and freshwater wetlands.

Some of the current disturbances include linear infrastructure (ie powerlines, gas and water pipelines, roads and railway lines), grazing, cropping and clearing/thinning. These activities, and the resultant impacts, affect the biodiversity, distribution and population dynamics of an area.

On a localised scale, habitat structure and subsequent value varies depending on anthropogenic and natural processes. The habitat value of the Mainland GTP RoW is largely dependent on microhabitat complexity, including:

- Groundcover type and density (ie grasses (native vs introduced) and leaf litter)
- Understorey composition and density
- Presence of rocky outcrops
- Presence of hollows
- Dead stags and exfoliating bark
- Soil type (ie cracking clays, sandy)

Microhabitats vary significantly within and between the habitats intersected by the Mainland GTP RoW. Table 9.13 outlines the key habitats and the existing disturbances identified within and adjacent the Mainland GTP RoW.

No declared fish habitat areas (as defined under the provisions of the *Fisheries Act 1994*) occur within the Mainland GTP RoW.

Essential Habitat (as mapped by DERM 2011) occurs within and/or adjacent to the Mainland RoW for the following species:

- *Melaleuca irbyana* (Swamp tea-tree)
- *Apatophyllum teretifolium*
- *Acacia gittinsii* (Gittins wattle)
- *Solanum dissectum*
- *Solanum johnsonianum*
- *Solanum elachophyllum*
- *Acacia pedleyi* (Pedley's wattle)
- *Desmodium macrocarpum* (Large-podded Tick-trefoil)
- *Acacia pubicosta*
- *Cossinia australiana* (Cossinia)



- *Cycas megacarpa* (Large-fruited zamia palm)
- *Macropteranthes leiocaulis* (Southern bonewood)
- *Cupaniopsis shirleyana* (Wedge-leaf tuckeroo)
- *Hernandia bivalvis* (Cudgerie)
- *Graptophyllum excelsum* (Letter leaf)
- *Taphozous australis* (Coastal sheathtail bat)



Table 9.13 Key habitats and existing disturbances within the Mainland GTP RoW

Area	Habitats within the Mainland GTP RoW	Significant fauna identified	Disturbances
Overview	<ul style="list-style-type: none"> • Sandstone cliffs with large rocky outcrops • <i>Eucalyptus</i> woodland with sparse mid-storey and a grassy understorey • Large woody debris • Burrow • Nests • Hollow bearing trees and stags 	<ul style="list-style-type: none"> • Squatter pigeons • Rainbow bee-eaters • Grey-crowned babbler • Restless flycatcher 	<ul style="list-style-type: none"> • Heavily cleared for grazing and mining activities • GTP ROW follows existing pipeline corridors • Wildfires in the last 12 months • Proliferation of introduced grass species in the understorey
Hutton Creek (moderate ecological value)	<ul style="list-style-type: none"> • Permanent waterbody • Hollow bearing trees • Instream complexity • Wildlife corridor – mainly bird and aquatic species 	<ul style="list-style-type: none"> • Platypus • White-throated snapping turtle • Hollow dependent fauna, incl. parrots, cockatoos and gliders 	<ul style="list-style-type: none"> • Cleared to the high water bank (no tailing vegetation) • Riparian zone approx. 40 m wide • Erosion and bank slippage present
Baffle Creek (high ecological value)	<ul style="list-style-type: none"> • Permanent waterbody • Sandstone cliffs with caves and overhangs • Habitat trees (eg hollow bearing trees) • High stream complexity and diversity (including riffles, pools) • Large rocky outcrops and boulders • Range of microhabitats spatially, including sandy areas, area with high level of detritus and alluvial clays • Wildlife corridor and core habitat • High carrying capacity due to the area, age and diversity of vegetation and habitats within the area 	<ul style="list-style-type: none"> • Evidence of bats roosting in caves and overhangs • Supports Little pied bat and potentially the Large-eared pied bat • Suitable habitat for the Northern quoll • Suitable habitat for the White-snapping turtle and potentially the Fitzroy River turtle • Likely refuge habitat during extended dry periods 	<ul style="list-style-type: none"> • Some evidence of grazing but it is localised • Grazing and mining activities in the upper catchment • Introduced plant species are sparsely distributed along the watercourse





Area	Habitats within the Mainland GTP RoW	Significant fauna identified	Disturbances
Baffle Creek to the Dawson River (moderate ecological value)	<ul style="list-style-type: none"> Primarily ironbark woodlands on metamorphic. Limited number of habitat trees and large woody debris Microhabitat complexity associated with the sandstone cliff faces (ie increase in ground cover diversity, presence of rocky outcrops and slaps, sandy and gassy areas etc) Overhangs and caves associated with the sandstone cliff faces Ephemeral watercourses present primarily having a bedrock substrate An unnamed watercourse to the north of Gas Road has a high degree of habitat complexity associated with the rocky outcrops, waterfalls and riparian vegetation (hollow bearing trees, complex communities) Brigalow along the sandstone cliffs down to the Dawson River <i>Eucalyptus populnea</i> woodland (regrowth and remnant) on alluvial plains 	<ul style="list-style-type: none"> Large number of bird and frogs associated with the area 	<ul style="list-style-type: none"> Wildfires in the last 12 months has severely impacted on habitat complexity Clearing and thinning in the ironbark woodlands, with pastoral grasses prominent in the understorey Evidence of gully and rill erosion Clearing for the construction of roads and gas wells
Dawson River to Pyramid Hill (moderate ecological value)	<ul style="list-style-type: none"> Mosaic of vegetation communities, including: <i>Eucalyptus populnea</i> woodland (regrowth and remnant) Remnant patches of Brigalow Brigalow regrowth Riparian and floodplain vegetation Palustrine wetlands and ephemeral watercourses Habitat trees and large woody debris Rocky slopes 	<ul style="list-style-type: none"> Brigalow scaly-foot Gliders Number of snake species Squatter pigeons High number of birds 	<ul style="list-style-type: none"> Grazing Erosion (gully and rill) Clearing for roads, LNG wells and agriculture Sections have been cleared resulting in dense patches of Brigalow regrowth





Area	Habitats within the Mainland GTP RoW	Significant fauna identified	Disturbances
Pyramid Hill to Expedition Range (limited ecological value)	<ul style="list-style-type: none"> Habitat mainly associated with riparian zones of watercourses intersected by the GTP ROW (eg Bully Frog Creek, Clematis Creek and Ironbark Creek) Riparian zones provide wildlife links between the Expedition Range and Carnarvon Range No permanent waterbodies, with watercourses ephemeral Small and disjunct patches of Brigalow regrowth Limited in stream complexity and stream diversity Habitat trees present in the riparian zones, but riparian complexity generally limited 	<ul style="list-style-type: none"> The area is part of the foraging habitat for the Square-tailed kite Grey-crowned babbler in Clematis Creek 	<ul style="list-style-type: none"> Primarily follows the Jemena Gas Pipeline Area is primarily grazing land (~90%) Area mapped as Brigalow (riparian zone of Bully Frog Creek) has been cleared and is in poor health Riparian zone of the watercourses generally restricted to the high water bank and there is generally limited trailing vegetation
Expedition Range (moderate to high ecological value)	<ul style="list-style-type: none"> Major wildlife corridor Rocky outcrops Caves and overhangs Mosaic vegetation communities, including patches of Brigalow, ironbark woodland on alluvial and rock areas, bloodwood woodlands Ephemeral watercourses Habitat trees Mosaic ground cover in areas but primarily grasses Large woody debris, burrows, hollow logs and rocky outcrops 	<ul style="list-style-type: none"> Gliders Rainbow bee-eaters Cave-dwelling and hollow-dependent bats Habitat is known to support a number of threatened flora species 	<ul style="list-style-type: none"> Existing Jemena Pipeline Corridor - barrier to movement of some species, also increase impacts associated with edge effects Wildfire in the last 12 months which has devastated a large area of vegetation (upper canopy showing epicormic growth while understory is dense area of <i>Solanum</i> and <i>Notelaea</i> spp.) Grazing in some areas





Area	Habitats within the Mainland GTP RoW	Significant fauna identified	Disturbances
Expedition Range to Dawson Range (limited ecological value)	<ul style="list-style-type: none"> Habitat mainly associated with riparian zones of watercourses intersected by the GTP ROW and open woodland with pastoral grasses near Simmons Road No permanent waterbodies, however the area adjoins Zamia Creek which is has permanent water and good riparian complexity. High habitat value associated with trailing vegetation to the west of Mimosa Creek Two palustrine wetlands Habitat trees mainly in the riparian zone of Conciliation Creek 	<ul style="list-style-type: none"> Frog habitats Reptile species 	<ul style="list-style-type: none"> Primarily follows the Jemena Gas Pipeline Area is primarily irrigated cropping and grazing land (~90%) Parthenium is prominent within the GTP ROW and in the watercourse (especially Conciliation and Zamia Creek catchments) Riparian zone of the watercourses generally restricted to the high water bank and there is generally limited trailing vegetation
Dawson Range to Calliope Range (limited ecological value)	<ul style="list-style-type: none"> Habitat mainly associated with riparian zones of watercourses intersected by the GTP ROW (~12) Adjoins disjunct patches of Brigalow, which are essential habitat for a number of flora species (Kianga Creek to Banana creek) Intersects Brigalow associated with a number of roads, including Theodore-Baralaba Road. Excluding the Dawson River no permanent waterbodies intersected by the GTP ROW. High habitat value associated with trailing vegetation to the west of the Dawson River and north of Banana Creek Gilgai areas (Between Neville Creek and the Burnett Highway) Palustrine wetland associated with Eucalyptus tereticornis on alluvial plains (mapped as non-remnant) on the eastern side of the Burnett Highway Habitat trees mainly in the riparian zones of the watercourses intercepted 	<ul style="list-style-type: none"> Raptor nest in a patch of Brigalow west of Ryders Road Known habitat for gliders (Palustrine wetland on the Burnett Highway) High diversity of frogs following recent rainfalls Watercourses can act as wildlife corridors and refugia habitat 	<ul style="list-style-type: none"> Primarily follows the Jemena Gas Pipeline Area is primarily irrigated cropping and grazing land (~90%) Parthenium and weeds are an issue put are not as prevalent as the area to the west of the Dawson Range Riparian zone of the watercourses generally restricted to the high water bank and there is generally limited trailing vegetation





Area	Habitats within the Mainland GTP RoW	Significant fauna identified	Disturbances
Calliope Range (moderate ecological value)	<ul style="list-style-type: none"> Area is primarily eucalypt woodlands , however some of the drainage lines support vine thicket communities and provide complex habitats No palustrine wetlands 	<ul style="list-style-type: none"> Greater and Yellow bellied gliders Known habitat for the Northern quoll (Mount Rainbow) Habitat is known to support a number of threatened flora species 	<ul style="list-style-type: none"> Primarily follows the Jemena Gas Pipeline Area has been impacted by: <ul style="list-style-type: none"> The upgrade to the Dawson Highway Moura Short Line The Jemena Gas Pipeline Grazing activities
Calliope Range to the Gladstone-Mount Larcom Road (limited ecological value – Calliope River, Harper Creek and Larcom Creek)	<ul style="list-style-type: none"> Habitat mainly associated with riparian zones of watercourses intersected by the GTP ROW (~11) <i>Eucalyptus moluccana</i> woodland on undulating slopes associated with Larcom Creek and Vallis Creek (between Larcom Creek and Gladstone-Mount Larcom Road) Major watercourses intersected include the Calliope River and also Larcom Creek (twice) High value areas are associated with Calliope River and also Larcom Creek Palustrine wetlands associated with the Calliope River (west of Duck Holes Road) and also Larcom Creek (East End Branch Line) Habitat trees present within the Mount Alma Road Corridor 	<ul style="list-style-type: none"> Squatter pigeons Gliders Powerful owl known to occur in the Mount Larcom and Aldoga area 	<ul style="list-style-type: none"> Area is primarily grazing land (~90%) Follows in part the Jemena Gas Pipeline and Mount Alma Road Riparian zone of the watercourses restricted to the high water bank and there is generally no trailing vegetation. The area is also impacted by weeds and cattle usage. Giant rat's tail grass and Parthenium known to occur
Gladstone-Mount Larcom Road to Targinnie State Forest (limited ecological value)	<ul style="list-style-type: none"> Habitat value mainly associated with patched of regrowth Area adjoins Semi-evergreen vine thicket communities 	<ul style="list-style-type: none"> Fruit-doves Red-tailed black cockatoos Powerful owl known to occur in the Mount Larcom and Aldoga area Squatter pigeons 	<ul style="list-style-type: none"> Area is primarily grazing land (~90%) Large percent of the area is also regrowth or Lantana prominent Giant rat's tail grass





Area	Habitats within the Mainland GTP RoW	Significant fauna identified	Disturbances
Targinnie State Forest and the eucalypt woodlands bordering Kangaroo Island (moderate ecological value)	<ul style="list-style-type: none"> • Wildlife corridor and core habitat • High carrying capacity due to the area, age and diversity of vegetation and habitats within the area • Diverse array of microhabitats, including hollow bearing trees, rocky outcrops, slopes and alluvial plains 	<ul style="list-style-type: none"> • Squatter pigeons • Gliders • Rainbow bee-eaters • A number of nests in <i>Melaleuca</i> saplings 	<ul style="list-style-type: none"> • Fire • Grazing • Clearing for agriculture • Weeds



9.4 Potential adverse or beneficial impacts on existing flora and fauna values (construction and operation)

This section addresses the potential impacts on existing flora and fauna within the Mainland GTP RoW and adjacent areas.

9.4.1 Vegetation clearing

Clearing of vegetation during construction, operation and decommissioning of the Mainland GTP will be restricted to the designated RoW, which is limited to a width of approximately 40 m in areas outside of ESA mapping and 30 m within.

Construction phase clearing activities within the Mainland GTP RoW will result in the disturbance of approximately 213.30 ha of remnant vegetation. A breakdown of the disturbance to REs as a result of this clearing is presented in Table 9.14. The table also outlines the estimated disturbance to each RE community as a percentage of the RE within the combined sub-regions (ie Mount Morgan Ranges, Callide Creek Downs, Banana-Auburn Ranges, Dawson River Downs, Arcadia, and Carnarvon Ranges).

Table 9.14 Construction phase vegetation clearing extent within the Mainland GTP RoW

RE	Biodiversity status	VM Act status	EPBC Act status	Area to be cleared within row (ha) ¹	Area within sub-regions ² (ha)	~ % of sub-regional extent ³
11.3.1	Endangered	Endangered	Endangered	0.02	3,723	0.00054
11.3.2	Of concern	Of concern	Endangered	6.62	107,505	0.00616
11.3.3	Of concern	Of concern	-	0.43	10,778	0.00399
11.3.4	Of concern	Of concern	-	4.00	32,477	0.01232
11.3.17	Endangered	Of concern	-	7.55	914	0.82604
11.3.25	Of concern	Least concern	-	3.54	58,910	0.00601
11.3.26	No concern at present	Least concern	-	5.76	14,776	0.03898
11.3.39	No concern at present	Least concern	-	0.08	125,001	0.00006
11.4.8	Endangered	Endangered	Endangered	0.13	1,892	0.00687
11.4.9a	Endangered	Endangered	Endangered	0.17	1565	0.01086
11.5.2	No concern at present	Least concern	-	12.72	9,037	0.14739
11.5.2a	No concern at present	Least concern	-	0.60		
11.5.5c	No concern at present	Least concern	-	2.83		
11.8.4	No concern at present	Least concern	-	8.14	31,145	0.02613
11.9.1	Endangered	Endangered	Endangered	0.19	3,220	0.00590
11.9.5	Endangered	Endangered	Endangered	2.87	25,838	0.22950
11.9.5a	Endangered	Endangered	Endangered	3.06		
11.9.9	No concern at present	Least concern	-	1.26	17,767	0.00709
11.10.1	No concern at present	Least concern	-	49.54	533,602	0.00928
11.10.3	No concern at present	Least concern	-	5.71	85,775	0.00666
11.10.4	No concern at present	Least concern	-	0.14	321,456	0.00004
11.10.7	No concern at present	Least concern	-	3.7	126,440	0.00439
11.10.7a	No concern at present	Least concern	-	1.85		

RE	Biodiversity status	VM Act status	EPBC Act status	Area to be cleared within row (ha) ¹	Area within sub-regions ² (ha)	~ % of sub-regional extent ³
11.10.13	No concern at present	Least concern	-	11.39	231,020	0.01798
11.10.13a	No concern at present	Least concern	-	30.15		
11.11.3	No concern at present	Least concern	-	2.20	55,081	0.00399
11.11.4	No concern at present	Least concern	-	2.34		
11.11.4a	No concern at present	Least concern	-	0.45		
11.11.15	No concern at present	Least concern	-	34.92	118,291	0.02975
11.11.15a	No concern at present	Least concern	-	0.27		
11.11.18	Endangered	Endangered	-	0.50	2,988	0.01673
11.12.1	No concern at present	Least concern	-	7.94	160,872	0.00494
11.12.6	No concern at present	Least concern	-	2.23	80,045	0.00279
TOTAL				213.30	2,188,636	1.48534

Table notes ¹ Calculations derived from RE data (version 6.0) provided by DERM. Heterogeneous REs have been separated for the purposes of these calculations based on their respective percentage divisions
² Derived from RE data for the Mt Morgan Ranges, Callide Creek Downs, Banana-Auburn Ranges, Dawson River Downs, Arcadia, and Carnarvon Ranges sub-regions as per Accad *et al.* (2008)
³ Indicates percentage of RE to be cleared within the Mt Morgan Ranges, Callide Creek Downs, Banana-Auburn Ranges, Dawson River Downs, Arcadia, and Carnarvon Ranges sub-regions

RE11.10.1 will be the RE most affected as a result of clearing during the construction phase (ie have the highest number of hectares cleared). This community has a 'no concern at present' Biodiversity Status, and is not listed under the provisions of the *EPBC Act* as a threatened ecological community. Approximately 49.54 ha of this RE is proposed to be cleared within the Mainland GTP RoW. This represents approximately 0.009% of this community found within the collective sub-regions.

As discussed in Chapter 1, REs with a Biodiversity status of Endangered are considered Class B ESAs under the provisions of the *Environment Protection Act 1994* (EP Act), whilst REs with a Biodiversity status of Of Concern are considered Class C ESAs. Thus, approximately 6.94 ha of Class B ESA and 14.59 ha of Class C ESA will be cleared during the construction phase of the Mainland GTP RoW.

Clearing activities associated with the construction phase will result in the clearing of approximately 13.56 ha of REs analogous to EPBC Act listed threatened ecological communities (Table 9.14).

As stipulated in the CG Report, impacts for necessary clearing of high value regrowth vegetation (HVRV), under the provisions of the VM Act have been considered. Construction activities will result in the clearing of approximately 36.16 ha of HVRV containing endangered RE. Approximately 42.39 ha of HVRV containing Of Concern REs and approximately 47.25 ha of HVRV containing Least Concern REs will also be cleared within the Mainland GTP RoW during the construction phase.

Ground-truthing of the Mainland GTP RoW will be necessary in order to identify any HVRV that is considered analogous to an EPBC Act threatened ecological community.

Mitigation measures including vegetation offsetting will be implemented for the unavoidable clearing of remnant and regrowth vegetation during the construction phase, in accordance with the EPBC Act approval and CG Report.

From an operational perspective, vegetation disturbance impacts along the RoW are likely to be restricted to maintenance activities. Adverse impacts associated with maintenance activities may include clearing of any regrowth vegetation that emerges following the construction phase (where necessary).

Minor impacts resulting from these activities will be managed through the SMP, SSMP and an Operational EM Plan, which will be produced prior to the completion of the construction phase. It is therefore considered that the potential impacts to vegetation during the operation phase of the Mainland GTP are expected to be low and manageable.

9.4.2 Conservation and commercially significant flora species

At least twelve (12) conservation significant flora species are known to occur within the Mainland GTP RoW (refer Section 9.3.3), and are therefore expected to be impacted by the construction, operation and decommissioning of the Mainland GTP.

Mitigation measures including vegetation offsetting will be implemented for the unavoidable clearing of conservation significant flora species during the construction phase, in accordance with the EPBC Act and CG Report. Additional mitigation measures will be implemented to minimise the potential risk of unexpected impact to these species (refer Section 9.6). A Significant Species Management Plan (SSMP) has also been prepared to specifically address the mitigation measures to be implemented to reduce the potential impacts to such species as well as presenting specific mitigation measures to prevent harm to Significant Species known to occur within the GTP RoW (Ecologica Consulting, 2010). If further Significant Species should be identified with the GTP RoW, the SSMP will be updated to include specific mitigation measures to protect such species. It is therefore expected that the potential impacts to conservation significant flora will be moderate and manageable during the construction and operational phases of the Mainland GTP.

Clearing of Type A restricted plants (commercially significant flora) within the Mainland GTP RoW will be necessary during the construction phase (refer Section 9.3.3) as prescribed by the CG Report. Mitigation measures (ie fencing-off) will be implemented to minimise any potential impacts to Type A restricted species during the construction and operation of the Mainland GTP (Refer Section 9.6). Mitigation measures for the avoidance and salvaging of Type A restricted plants are specifically addressed in the SSMP and the LRMP (refer Appendix G), in accordance with the CG Report. It is therefore expected that the potential impacts to Type A restricted species will be moderate and manageable during the construction of the Mainland GTP.

Potential disturbance to Type A restricted plants during the operation of the Mainland GTP may also occur as a result of maintenance activities (ie vehicular movement etc). Minor impacts resulting from these activities will be managed through the SMP, SSMP and an Operational EM Plan, which will be produced prior to the completion of the construction phase. It is therefore expected that the potential impacts to Type A restricted species will be low and manageable during the operational phase of the Mainland GTP.

9.4.3 Dust impacts on adjacent vegetation

Deposition of dust, sand and soil may have potential impacts on vegetation if excessive levels are sustained over extended periods. When dust settles on plant foliage, it can reduce the amount of light penetration on the leaf surface, block and damage stomata, and slow rates of gas exchange and water loss. Reduction in the ability to photosynthesise due to physical effects may result in reduced growth rates of vegetation and decreases in floral vigour and overall community health. The potential effects of dust deposition on vegetation are determined by a number of factors including:

- The characteristics of leaf surfaces, such as surface roughness, influencing the rate of dust deposition on vegetation
- Concentration and size of dust particles in the ambient air and its associated deposition rates
- Local meteorological conditions and the degree of penetration of dust into vegetation communities

The dominant flora species that occur along the Mainland GTP RoW, typically exhibit physiological qualities that are not sensitive to dust deposition. The sclerophyllous foliage of *Eucalyptus* and *Corymbia* species is generally pendulous (ie points down), with a thick smooth cuticle that does not encourage particulate matter to remain on the surface. The dominant woodland species are also generally hardy and well adapted to adverse conditions (eg extended dry conditions, dust and low nutrient soils) (URS, 2009).

It is unlikely that dust deposition impacts will be significant during the operational phase of the Mainland GTP. Minor impacts resulting from these activities will be managed through an Operational EM Plan, which will be produced prior to the completion of the construction phase. It is therefore expected that construction and operational dust impacts will be low and manageable.

9.4.4 Weeds

Very few Weeds of National Significance (WONS) and species declared under the provisions of the LP Act were detected within the Mainland GTP RoW, as discussed in Section 9.3.3.

Parthenium and Giant rat's tail grass are known within the Mainland GTP RoW, and have the greatest potential to significantly impact upon grazing and ecological values. Lantana (*Lantana camara*) has also been detected at numerous locations throughout the Mainland GTP RoW.

These weeds are considered aggressive, and could easily be introduced to new areas through poor weed hygiene practices during all phases of the Project (ie pre-construction, construction, operation and decommissioning). Introduction to areas previously free of infestations could result in major impacts, including loss of grazing potential, increase in fuel load, alteration of vegetation structural complexity, reduction in habitat value and increase in risk to human health.

Control measures will be implemented to minimise the risk of spreading *Parthenium*, Giant rat's tail grass, and other declared weeds (WONS and LP Act declaration) during the construction and operational phases of the Mainland GTP (refer Section 9.6 and the Pest and Weed MP (Appendix D)). It is therefore anticipated that construction and operational weed impacts will be low and manageable.

9.4.5 Edge effects

The fragmentation and modification of ecosystems following land clearing can lead to changes in physical edge effects (Lindenmayer & Burgman, 2005). These edge effects occur when disturbances to the edge of a habitat or ecosystem result in a change or disturbance to the interior of that area. Examples of edge effects that may be associated with vegetation communities of the Mainland GTP RoW include weed invasion and altered micro-climatic conditions.

Edge effects are likely to impact upon the habitats and/or ecosystems within and adjacent to the Mainland GTP RoW, as a result of vegetation disturbance associated with the construction, operation, maintenance and decommissioning activities.

Mitigation measures will be implemented to minimise the impact of clearing during the construction and operational phases of the Mainland GTP (refer Section 9.6). Edge effects will be managed during the operational phase by an Operational EM Plan, which will be produced prior to the completion of the construction phase. It is therefore expected that edge effect impacts during the construction and operational phases will be low and manageable.

9.4.6 Changes to fire regimes

The majority of Australian terrestrial ecosystems and many endemic flora species are threatened by inappropriate fire regimes (Lindenmayer & Burgman, 2005). Changes to the landscape as a result of vegetation clearing could potentially impact the fire regime of the vegetation communities within close proximity to the Mainland GTP RoW. These impacts are dependent upon several factors, including type of vegetation community, fire history, weather and rainfall history.

The invasion and establishment of exotic grasses following vegetation clearing activities may alter the frequency and intensity of fire by increasing fuel loading in some cases. However, regular clearing (ie maintenance) would lower the fire hazard.

Fuel loads and potential sources for accidental ignition of fires will be managed during construction of the Mainland GTP (refer Section 9.6). Fire effects will also be managed during the operational phase by an Operational EM Plan, which will be produced prior to the completion of the construction phase.

9.4.7 Erosion and sedimentation

There is potential for erosion of areas disturbed by works associated with construction, operation and decommissioning of the Mainland GTP (refer Chapter 7). Where these activities occur on erosive soils and/ or on slopes, mobilisation of sediment into ephemeral watercourses can occur.

Potential impacts to aquatic ecosystems can include build-up of sediment in waterholes with a subsequent reduction in available habitat, smothering of aquatic plants and substrate, and cumulative downstream impacts on sensitive estuarine and marine habitats (including the intertidal areas of Kangaroo Island Wetlands).

Control measures will be implemented to minimise erosion and sedimentation during the construction and operational phases of the Mainland GTP (refer Section 9.6 and the ESCP; Appendix A). Erosion and sedimentation impacts will also be managed during the operational phase by an Operational EM Plan, which will be produced prior to the completion of the construction phase. It is therefore expected that erosion and sedimentation related impacts during the construction and operational phases will be low and manageable.

9.4.8 Loss of habitat

Construction of the Mainland GTP will result in the loss of fauna habitat (of varying quality) through initial site preparation and construction-related clearing activities.

Approximately 34 ha of mapped 'Essential Habitat' will be cleared within the RoW to accommodate the Mainland GTP. Management measures for the protection of Essential Habitat during construction of the Mainland GTP RoW will be implemented, and are presented in Table 9.15.

Clearing activities are also expected to result in the removal of general habitat features such as trees, shrubs, ground cover, rocks and timber within the Mainland GTP RoW.

Members of all faunal groups may be disturbed by the activities associated with the construction, operation (including maintenance), and decommissioning of the Mainland GTP. Small ground mammals (eg rodents and insectivorous marsupials), reptiles and amphibians may be directly disturbed by vehicular movement and groundbreaking activities. As many species within these groups shelter within or utilise ground habitat features, there is the potential for these groups to be affected by these works.

Fauna utilising arboreal hollows and feeding resources such as possums, gliders and many species of birds (including Powerful owl) and insectivorous bats, may be affected by the removal of these habitat features during construction of the Mainland GTP.

While the loss of habitat may affect certain types of birds, the alteration may be beneficial to others. An example, in a woodland area, the displacement of forest birds may result in a subsequent replacement by grassland species in the vicinity of the Mainland GTP RoW. However, it may be expected that disturbance tolerant species prevail in these instances.

Mortality impacts and predator prey disruption from habitat loss are expected to be relatively low in the context of the overall landscape ecology.

Control measures will be implemented to minimise potential impacts to habitat loss (ie salvaging of hollows, restriction of clearing etc) during construction (refer Section 9.6). It is therefore expected that impacts relating to habitat loss will be moderate, but manageable during construction of the Mainland GTP.

Impacts relating to habitat loss during operation of the Mainland GTP will be managed by the SMP, SSMP and an Operational EM Plan which will be produced prior to the completion of the construction phase. A summary of operational mitigation measures is included in Section 9.6. Impacts relating to habitat loss during the operational phases will be low and manageable.

9.4.9 Fragmentation and Loss of Movement Opportunities

Construction and operational activities within the Mainland GTP RoW are likely to create movement barriers for certain species. Fauna such as small mammals and birds are often deterred from crossing cleared/open areas, or areas subject to noise, vibration and lighting. In addition, the crossing of such areas can increase the potential for predation by native and introduced predators.

Gliders (which are known to occur within the RoW) move through bushland by volplaning, or gliding from tree to tree. For *Petaurus norfolcensis* (Squirrel glider) and *Petaurus breviceps* (Sugar glider), the maximum volplaning distance is approximately 60 m. For *Petauroides volans* (Greater glider) and *Petaurus australis* (Yellow-bellied glider), the maximum volplaning distance can exceed 100 m. Often distances travelled are much less (20 to 30 m), and are partly dependant upon the height of trees utilised (Lindenmayer, 2002). The clearing of the RoW is not expected to have a significant effect on glider movement (depending upon local vegetation patterns).

Fragmentation of remnant vegetation can result in a reduction of functional habitat. Habitat alteration may potentially result in certain species abandoning the area. Edge effects compound the impacts of fragmentation so that functional habitat is further reduced. Reduced buffers to core habitat will result in disturbances to fauna and a further reduction in habitat quality. The disturbance of soil and increased light levels will potentially enhance conditions for weed infestations (edge effects).

Construction and operation of the Mainland GTP RoW is expected to have moderate long term impacts with regard to fragmentation and loss of movement, particularly where the RoW bisects large stands of vegetation.

Control measures will be implemented to minimise potential impacts to faunal movement opportunities during construction of the Mainland GTP (refer Section 9.6). Subsequently, the impacts relating to fauna movement are likely to be reduced to low and manageable.

Impacts relating to fauna movement opportunities during operation will be managed by an Operational EM Plan. This plan will be produced prior to the completion of the construction phase. Impacts relating to fauna movement opportunities during operation of the Mainland GTP are expected to be low and manageable.

9.4.10 Conservation significant fauna

Conservation significant species known within the vicinity of the Mainland GTP RoW include Collared delma, Brigalow scaly-foot, Golden-tailed gecko, Black-necked stork, Squatter pigeon, and White-bellied sea-eagle. As discussed in Section 9.3.4, a number of migratory birds are also known from the habitats within and adjacent to Mainland GTP RoW.

Evidence of Koala activity within the vicinity of the Mainland GTP RoW is scant (refer Section 9.3.4). However, should this species occur within the Mainland GTP RoW, population densities would be expected to be low to moderate.

Potential direct and indirect impacts to these species are likely to occur within the construction phase of the Mainland GTP RoW, where clearing of vegetation will result in the loss of habitat (ie hollows, foraging material, shelter), fragmentation and temporary noise and vibration. Nutrient runoff from construction of the Mainland GTP RoW may compromise the quality of water within freshwater and intertidal wetlands adjacent to the RoW, where conservation significant migratory and resident shorebirds are known or likely to occur during certain times of the year.

It is important to note that Powerful owls are known to be highly sensitive to disturbance (ie noise, vibration, lighting etc) and may desert a nest after minimal human disturbance, particularly early in the nesting season.

The SSMP specifically addresses impacts and mitigation measures for conservation significant fauna species that are known or likely to occur within the vicinity of the Mainland GTP RoW. The adoption of appropriate management strategies during clearing will reduce potential impacts to conservation significant fauna during construction of the Mainland GTP (refer Section 9.6). It is therefore expected that impacts relating to significant fauna will be moderate and manageable during construction of the Mainland GTP RoW.

Impacts relating to significant fauna during operation of the Mainland GTP will be managed through the SMP, SSMP and an Operational EM Plan. This Operational EM Plan will be produced prior to the completion of the construction phase. Impacts relating to significant fauna during the operational phase are expected to be low and manageable.

9.4.11 Fauna injury and mortality

Potential impacts relating to fauna mortality during construction of the Mainland GTP are likely to occur during associated clearing and trenching activities within the RoW. Such activities may result in fauna mortality relating to displacement, resource competition, and vehicle/machinery strikes.

In addition to the possibility of some fauna mortality occurring during clearing activities, the loss of nesting resources may affect local prey and predator fauna populations into the future. Avian fauna may be less affected by the proposal due to their ability to easily move from the zone of impact. However, it must be noted that the Powerful owl is known to abandon nests with minimal human disturbance, particularly early in the season (refer the SSMP for specific mitigation measures).

During the GTP trenching phase, the open trench will create an obstacle for fauna. The trench may effectively act as a large pitfall trap where fauna may fall in and fail to escape. The most serious implication for fauna is mortality related to heat stress and entrapment.

Implementation of appropriate strategies (eg exclusion fencing) will considerably reduce the potential for fauna mortality (refer Section 9.6). It is therefore considered that impacts relating to fauna mortality during construction of the Mainland GTP RoW will be low and manageable.

Impacts relating to fauna mortality during operation of the Mainland will be managed through the SMP, SSMP and an Operational EM Plan. This Operational EM Plan will be produced prior to the completion of the construction phase. A summary of operational mitigation measures is included in Section 9.6. Impacts relating to fauna mortality during the operational phase are expected to be low and manageable.

9.4.12 Pests

Introduction and proliferation of pest species within and adjacent to the Mainland GTP RoW during construction and operational phases may cause significant environmental harm when appropriate mitigation measures are not implemented.

Anoplolepis gracilipes (Yellow crazy ants) and *Solenopsis invicta* (Fire ants) are exotic species that have the potential to seriously impact on native flora, fauna and ecological communities. They are capable of being transported from infested sites to new construction sites on equipment or within materials. Whilst many colonies of both species have been eradicated elsewhere in Queensland, there remains a chance of spreading ants to new areas.

Additional pests species (as discussed in Section 9.3.4) are known to occur within the Mainland GTP RoW (ie Feral pigs, Feral cats, Dogs, Dingos, European rabbits, Cane toads etc). It is considered unlikely that the proposed works will result in a proliferation of these species.

Control measures will be implemented, (with consideration to the existing EPBC Act Threat Abatement Plans for Feral pigs, Feral cats, Red fox, European rabbit, and Cane toads) to minimise potential for pest introduction and proliferation during construction of the Mainland GTP (refer Section 9.6). It is therefore considered that pest related impacts during the construction phase of the Project will be low and manageable.

Pest related impacts during the operational phase will be managed through the PWMP and an Operational EM Plan. This Operational EM Plan will be produced prior to the completion of the construction phase. Pest related impacts during the operational phase are expected to be low and manageable.

9.4.13 Noise and vibration

Secondary impacts to fauna include disturbance from noise and vibration during construction and operation of the Mainland GTP. Fauna displacement will often occur as a result of noise and vibration impacts.

Construction related noise and vibration impacts associated with construction of the Mainland GTP will be of a temporary nature, and may have the greatest impact on those less mobile species.

Control measures will be implemented to minimise potential noise and vibration impacts to fauna during construction of the Mainland GTP (refer Section 9.6 and Chapter 10). It is

therefore considered that noise and vibration related impacts during construction of the Mainland GTP will be low and manageable.

Noise and vibration are not expected to be significant issues within the operational phase. Despite this, noise and vibration impacts during operation of the Mainland GTP will be managed by an Operational EM Plan. This plan will be produced prior to the completion of the construction phase. Impacts relating to noise and vibration during the operational phase are expected to be low and manageable.

9.4.14 Lighting

The use of lighting for both work and security may have both positive and negative impacts on fauna within the area. DEWHA (2009) refer the impact of “excessive” lighting which may improve the ability of predators (including Powerful owls) to detect roosting birds and small mammals.

Artificial light during construction within the Mainland GTP RoW may enable some species to increase feeding rates which could compensate for declines during the day as a result of noise and vibration disturbance.

Construction related lighting impacts will be of a temporary nature, and will not be an issue following construction of the Mainland GTP RoW.

Control measures (ie shaded lighting) will be implemented to mitigate lighting impacts to fauna during the construction and operational phases of the Mainland GTP (refer Section 9.6).

Lighting related impacts during the operational phase will be further managed by an Operational EM Plan. This plan will be produced prior to the completion of the construction phase. Impacts relating to lighting during the operational phase are expected to be low and manageable.

9.4.15 Construction camps

Construction camps are required to house and accommodate the construction personnel for the Mainland GTP. Four camp sites have been defined and have been located at the following locations (also refer Figure 2.4):

- Camp 1 – Bundaleer – KP 75
- Camp 2 – Bauhinia – KP 180
- Camp 3 – Banana – KP 275
- Camp 4 – Calliope – KP 355

These construction camps will be sized to accommodate approximately 450 persons at main camps and 200 persons at behind and advanced camps. An area of approximately 8 ha will be required for each camp. To minimise potential adverse environmental impacts associated with the initial clearing of the camp areas and then the construction of the camps themselves, the management measures outlined in Table 9.15 will be implemented.

The size of construction camps will decrease as construction activities in their particular areas are completed. Pre-fabricated modular buildings (camp units) will then be transported to the next location and installed to accommodate construction personnel shifting from one section to the next. Once all camp facilities have been relocated to the next location, the site will be rehabilitated as per the measures outlined in the LRMP (refer to Appendix G) and Chapter 15 of this EM Plan.

Based on the implementation of measures outlined in Table 9.15 and the LRMP (refer to Appendix G), it is considered that impacts associated with the construction, operation and decommissioning of construction camps will be low and manageable.

9.5 Cumulative impacts

Cumulative impacts on flora and fauna are described below. This cumulative impact assessment is based on the impact scope, identification and scoring methodology described in Chapter 2 of this EM Plan. Clearing of the RoW for multiple projects may adversely impact on terrestrial flora and fauna through direct loss of species or by increasing fragmentation of terrestrial habitat. The cumulative impacts on flora and fauna range from negligible to moderate negative. All three GTPs impact areas of 'Endangered' and 'Of Concern' 'Sub-Dominant' Regional Ecosystem within the Callide CIC. The pipelines impact some areas of 'Of Concern' 'Sub-Dominant' and 'Not of Concern' remnant vegetation RE, also within the Callide CIC.

9.5.1 Terrestrial flora (Regional Ecosystems/Threatened Species)

The majority of the CIC and GSDA corridors are located within highly disturbed areas that have been cleared for cropping or grazing activities. All LNG EIS's stipulate that GTP corridors have been selected to avoid high quality vegetation wherever possible.

Remnant vegetation along the shared route is located in the NIC and includes:

- Of Concern Regional Ecosystem *Eucalyptus tereticornis* and/or *Eucalyptus* spp. tall woodland on alluvial plains, located south of Gladstone-Mount Larcom Road
- Areas of Least Concern vegetation are located within or in close proximity to the pipeline route

Two species of conservation significance are known to occur in the Callide and Calliope Ranges. These include:

- *Cycas megacarpa* is listed as Endangered under both the *Nature Conservation Act 1992* and the *Environmental Protection and Biodiversity Conservation Act 1999*. This species has been identified in the CIC pipeline corridor just north of where it intersects the Callide Range (EIS 2009)
- *Acacia pedleyi* is listed as rare under the *Nature Conservation Act 1992*. This species has been identified in the pipeline corridor at the intersection of the Callide Range (EIS 2009)

The combined loss of communities and protected species resulting from the removal of vegetation within the ROW is a simple additive impact that has already been considered in each project's EIS. Hence, direct cumulative impacts on loss of vegetation, habitat or individual species are not considered further.

There will be moderate negative (permanent) cumulative impacts on terrestrial flora (regional ecosystems/threatened species).

9.5.2 Terrestrial flora (edge effects: altered hydrogeology/dust/fuel spills)

Any vegetated areas that are retained within the corridor and the areas of adjoining native vegetation may be exposed to increased edge effects as a result of the cumulative actions of the GTP and other infrastructure projects, particularly where these result in extended time frames for impacts.

Vegetation particularly sensitive to impacts from edge effects include communities located at:

- The northern end of the NIC that contains Endangered RE communities
- The south of the Gladstone-Mount Larcom Road that contain Of Concern RE
- Waterway crossings

Edge effect impacts may include:

- Dust deposition impacts on this vegetation could also be intensified by overlapping construction activities which result in increased overall dust levels or prolonged where the construction programs do not overlap. A prolonged impact over several seasons may be particularly detrimental to vegetation as natural growth and seeding cycles may be affected by dust deposition. Each project will need to strictly manage dust levels to minimise deposition on adjacent vegetation
- The potential for contamination of stormwater runoff, and contaminant levels in stormwater runoff are both potentially increased by overlapping construction activities. This can be addressed through erosion and sediment control
- Localised changes to the hydrology and hydrogeology altering runoff, reducing water infiltration and compaction of soils
- Accidental encroachment of construction activities beyond boundary fence
- Pollution from spills or contaminated runoff

Such edge effects could be worsened by fragmentation of vegetation communities, creation of larger edge zones and islands of isolated vegetation more vulnerable to edge effects.

Extended construction timeframes could result in longer rehabilitation times of the GTPs, which may allow invasive species to proliferate.

If management measures undertaken by each proponent to manage these impacts for each individual project are effective, cumulative impacts will be minimised. Hence, while additional management measures are not proposed in relation to cumulative impacts, the importance of management measures to address edge effects for each project must be highlighted.

There will be minor negative cumulative impacts on terrestrial flora (edge effects/altered hydrology/dust/fuel spills).

Potential additional mitigation measures that will be considered during the preconstruction and construction phases of the Project are:

- Management measures to manage edge effects must be of a higher standard than if each project was being undertaken individually
- Clearly defined and demarcated areas of vegetation clearance for each project, with agreed markers for “no go” areas
- Jointly review construction layouts to minimise small unviably ‘islands’ of uncleared areas within the alignment
- Consider the creation of a continuous vegetated buffer either side of the combined alignments during the main construction activities
- Consider low pressure water sprays on vegetation during the dry season if dust deposition occurs over extended periods

9.5.3 Terrestrial flora (weeds)

Potential for cumulative impacts from weed invasion is likely as having multiple projects constructing at similar times and locations may increase the amount of soil being disturbed. Therefore the risk of spreading weeds could be exacerbated over and above that of each project. This is related to the volume of traffic and transport of vehicles/machinery,

spoil/topsoil and personnel entering the area, thereby increasing the risk of contamination of weed seeds to the ROW and associated area.

The weed procedures and mitigation used for each project will be reliant on the enforcement for all projects i.e. if one project is not as diligent as others, there is an increased risk of weed infestation in other project areas.

Overlapping activities over the varying pipeline RoWs and construction schedules may also exacerbate the spread of weeds by encouraging the multiple reworking of excavated material and topsoil through successive phases of development.

Overall, the risk of weed invasion for multiple projects is exacerbated compared to individual projects, and each project must be more diligent in relation to weed prevention and management than would be the case for individual projects occurring in isolation.

There will be moderate negative cumulative impacts on terrestrial flora (weeds).

Potential additional mitigation measures that will be considered during the preconstruction and construction phases of the Project are:

- Co-locate the construction RoW to minimise the total amount of vegetation/ soil being disturbed.
- Share associated construction infrastructure where possible to reduce the amount of vegetation being disturbed.
- Investigate the potential for a joint weed control program.
- Maintain diligence in relation to weed management from each project.
- Investigate the potential for joint washdown bays/facilities.

9.5.4 Terrestrial fauna (habitat loss)

The majority of the Mainland GTP corridors have been cleared of native vegetation for agricultural land use, including grazing and cropping. In these areas relatively low numbers of terrestrial fauna are likely to be encountered.

Common fauna likely to be encountered include:

- Amphibians, comprising a range of frog species such as treefrogs
- Birds such as honeyeaters, shrike-thrush, figbirds, lorikeets and monarchs
- Mammals such as possums, gliders and koalas
- Reptiles, including snakes and skinks

As discussed above it is assumed that a significant amount of all habitats within the corridor of the schemes will be cleared of existing vegetation communities. The combined loss of fauna habitat resulting from the removal of vegetation within the projects' RoWs is a simple additive impact that has already been considered in each project's EIS. Hence, direct cumulative impacts of loss of habitat are not considered further.

With multiple projects, localised fragmentation (see below) and wider edge effects (weeds, dust, noise disturbance etc) potentially add to the loss of habitat.

The corridors themselves would be subject to permanent vegetation control which will limit suitability as fauna habitat in longer term habitat loss effects.

9.5.5 Terrestrial fauna (fragmentation, death and injury)

Potential cumulative impacts include increased fragmentation of terrestrial fauna habitat, particularly where this results in fauna moving across construction areas, either to escape from vegetation clearing, or to access other habitat areas.

This fragmentation is likely to be magnified by concurrent access and cumulative site vehicle movements or where open trenches could result in the increase in the number of fauna trapped in multiple open trenches.

Cumulative impacts will be greatest in areas of high fauna habitat value and recognised migration/biodiversity corridors where it can be expected that animals will be seeking to move across the construction areas. These areas include:

- Endangered RE at the northern end of the NIC (near Targinie) (also a state bioregional corridor)
- Remnant regrowth areas along the Calliope River
- Callide and Calliope Ranges

An extensive state listed bioregional corridor also extends across all GTPs, which is located outside the CIC and GSDA area. This corridor could be exposed to cumulative impacts for fauna migration. However, given that the pipelines will be rehabilitated after the construction phase, significant long term cumulative impacts are unlikely to interrupt fauna movement or result in habitat fragmentation.

Fragmentation may also be most prevalent in areas where the GTP corridors start to diverge, resulting in multiple potentially wider corridors, containing isolated islands of habitat, further impeding fauna movements and increasing edge effects, particularly through the NIC corridor.

In these locations in particular these animals may be vulnerable to death or injury from construction vehicles and trench fall as they cross the construction area, and the likelihood of death and injury may increase cumulatively with the multiple projects either due to increased hazards or from an increased mortality over an extended period of time

If the clearing of vegetation for the RoWs occurs successively and results in the creation of 'islands' of retained habitat within the corridor it may lead to trapping of fauna in small pockets of vegetation as they attempt to escape later stages of clearance. Although once all construction activities have ceased and rehabilitation has taken place, there will be fewer long term barriers to animal movements although the absence of vegetation cover means that there will be a residual barrier to animal movements.

There will be moderate negative (permanent) cumulative impacts on terrestrial fauna (fragmentation, death and injury).

Potential additional mitigation measures that will be considered during the preconstruction and construction phases of the Project are:

- Increased diligence in maintaining effective fauna crossing of the alignments
- Increase diligence of implementation of fauna protection measures for individual projects

9.5.6 Terrestrial fauna (light/noise and vibration)

Construction activities may impact on terrestrial fauna species from night lighting, and noise and vibration. Multiple RoWs may potentially have a wider area of disturbance.

Construction working hours are understood to be day only and may cease during night hours and are therefore unlikely to disturb nocturnal fauna.

Activities could interfere with breeding and a 24 month phase of construction activities in the area could worsen impacts on fauna in habitat adjacent to the corridor by disturbing two breeding cycles.

Fauna may be disturbed by noise from construction during the day. At any given point the most likely cumulative impact may be the prolonged noise disturbance. However, most fauna may be able to move away from noisy activities. Impacts may arise if noise and vibration extends through the breeding season of sensitive fauna.

There will be minor negative cumulative impacts on terrestrial fauna (light/noise and vibration).

Potential additional mitigation measures that will be considered during the preconstruction and construction phases of the Project are:

- Increased diligence on site traffic including speed limits
- Do not leave lights on at night if construction works are not taking place (unless required for safety)

9.5.7 Freshwater aquatic fauna (habitat loss and fragmentation)

The majority of creek crossings in the CIC and GSDA consist of semi-permanent waterways. Much of the riparian vegetation has been previously cleared for agricultural use (EIS, 2009).

However the larger streams provide limited habitat for a variety of fish species such as gudgeons, glassfish, hardheads and rainbowfish, freshwater snakes and river turtles.

Listed freshwater aquatic species that may be in the area include:

- Fitzroy River turtle (listed as Vulnerable under the EPBC Act and the NC Act) is present along the pipeline routes and potential habitat may be present in the CIC or GSDA corridors
- *Ornithorhynchus anatinus* (Platypus), listed as Least Concern under the NC Act is likely to be present in waterways throughout the pipeline corridors

The construction of multiple separate GTPs may result in native freshwater aquatic fauna habitat loss. Each LNG Project is understood to have considered this habitat loss in their EIS and direct loss of habitat is considered to be additive rather than cumulative.

Cumulative impacts of habitat degradation may occur from the increased spread of weeds, removal of native vegetation from the creek banks and changes to hydrology and from fragmentation of riparian and stream bed habitat that may take place if more than once crossing is constructed at the same time.

The creation of temporary bridges or culverts across water courses could create barriers to fish or other aquatic fauna movement. The presence of more than one barrier on an individual watercourse put in place by different projects could represent a cumulative barrier to migration and /or isolate populations within a stretch of watercourse.

Consecutive construction of the GTPs in this area may lead to extended disruption to aquatic habitat. Rehabilitation of the vegetation along the banks and reinstatement of creek beds after construction means that cumulative impacts will not be permanent.

The combined loss of aquatic fauna habitat resulting from the removal of vegetation within the RoW at waterway crossings is a simple additive impact that has already been considered in each project's EIS. Hence, direct cumulative impacts on loss of aquatic vegetation, habitat or individual species are not considered further.

There will be minor negative cumulative impacts on freshwater aquatic fauna (habitat loss and fragmentation).

Potential additional mitigation measures that will be considered during the preconstruction and construction phases of the Project are:

- Increased diligence with regards to rehabilitation procedures and protocols

9.5.8 Freshwater aquatic fauna (hydrology/hydrogeology)

There are a number of permanent or semi-permanent water bodies that are crossed by multiple RoWs in close proximity.

Altered flow regimes may impact on hydrology causing disturbance to riparian vegetation/stream habitat and impacts on the health and movement of aquatic fauna species as above.

The majority of creek crossings will be constructed by open trenching, with horizontal directional drilling used for some crossings where there is high stream flow or sensitive habitat.

Cumulative impacts are most likely to occur at locations where there is overlapping work on individual watercourses.

There will be minor negative cumulative impacts on freshwater aquatic fauna (hydrology/hydrogeology).

Potential additional mitigation measures that will be considered during the preconstruction and construction phases of the Project are:

- Avoid crossing designs which permanently alter flow stream flows

9.5.9 Freshwater aquatic flora and fauna (impacts on water quality from hydrotest water disposal/spills of fuel and oil/turbidity and sedimentation)

Aquatic flora and fauna may experience a variety of impacts from releases of pollutants associated with construction works comprising:

- The Creeks may be subject to increased suspended solids resulting from erosion by storm water run-off
- Accidental releases of pollutants such as HDD fluid, fuels, oils and other contaminants from site works
- Discharge of hydrotest water - Hydrotest water may be treated with additives such as biocides, corrosion inhibitor and oxygen scavengers, which may impact on local waterways. However, assuming that hydrotest water will either be allowed to soak away without direct discharge into a watercourse or treated prior to release, no cumulative impact on freshwater aquatic flora and fauna is anticipated

These impacts will all be subject to project specific controls. Assuming these are effective, the cumulative impacts would be limited to the prolonging of low level impacts by the combined programme of multiple separate projects.

There will be negligible cumulative impacts on freshwater aquatic fauna (water quality).

9.6 Environmental protection commitments, objectives and control strategies – flora and fauna

Table 9.15 below identifies the typical management measures that will be implemented during the pre-construction and construction phases of the project to manage the projects impacts on the pre-development flora and fauna environment.

In the case of the significant flora and fauna species that have been identified within the Mainland GTP RoW, specific management measures for the protection of these species are provided in the SSMP. Where mitigation measures presented in this EMP contradict those listed in the SSMP for the protection of conservation significant flora and fauna species, the SSMP prevails and the EMP will be updated to remove the contradiction.

In order to meet the requirements of conditions 3b and 3c of the EPBC Referral Approval (2008/4096), specific measures will be undertaken to manage the impact of clearing on each listed threatened and migratory species and each ecological community as per the approved SSMP.

Table 9.15 Proposed mitigation measures for the management of flora and fauna

Item	Detail
Environmental Protection Objective	<ul style="list-style-type: none"> To minimise and manage impacts to the ecological values of the gas transmission pipeline project area and to rehabilitate disturbed areas to as close as practical to the pre-construction condition
Specific Objectives	<ul style="list-style-type: none"> Minimal disturbance of terrestrial flora and fauna during construction of the pipeline, associated tracks, services and accommodation facilities No unplanned or unapproved damage to flora and fauna No overall net loss of threatened species or communities To restore the RoW to be compatible with the surrounding conditions and pre-construction land use and compatible with the pipeline's operation No spread of weeds and compliant with the Weed Management Plan Reduce the likelihood of the spread of weeds Control programs shall be prioritised to high risk areas adjacent to land of conservation significance Topsoil and vegetation material will be respread in the immediate vicinity of the area of origin to limit the potential spread of weeds and pathogens

Item	Detail
Control Strategies	<p>Preconstruction phase</p> <ul style="list-style-type: none"> • No clearing of protected vegetation for field development will occur until appropriate permits have been obtained • Ensure that all the approval conditions have been addressed or adequate measures are included in the relevant management plans to address these conditions • Ensure that professionals are engaged to undertake specialist environmental investigations • ESAs including, but not limited to, the following will be clearly defined and mapped: <ul style="list-style-type: none"> – Areas containing remnant vegetation with a biodiversity status of Endangered of Of Concern – Areas protected under the NC Act, Forestry Act or Fisheries Act (ie national parks, conservation parks, forest reserves, state forest parks, scientific area, declared fish habitat areas etc; refer Section 9.3.3) – Areas mapped as essential habitat under the provisions of the VM Act • In addition, the following Ecologically Sensitive Areas (ESAs) will be clearly defined and mapped: <ul style="list-style-type: none"> – Vegetation communities listed under the EPBC Act (eg Brigalow) – Riparian zones of watercourses with a stream order above 3 – High value habitat for threatened species known to inhabit the local areas • Prior to construction, an assessment will be undertaken of the condition, type and ecological value of any vegetation in such areas where the activity is proposed to take place. The assessment must be undertaken by a suitably qualified person(s) and include the carrying out of field validation surveys, observations and mapping of any category A, B or C ESAs. Ground truth, delineate and biocondition assess significant communities and the presence of species classed as endangered or vulnerable, under the provisions of the NC Act and any other species listed in the SSMP • Where possible ESAs will be avoided or measures will be implemented prior to and during construction to minimise the impacts
	<ul style="list-style-type: none"> • Construction will be scheduled for the dry season wherever possible. • Prior to carrying out field based activities, make all relevant staff, contractors or agents carrying out those activities, aware of the location of any category A, B or C ESA's and the requirements of this environmental authority. • All contractors and staff will be briefed on the environmental values of the area and that all native fauna are protected, including snakes prior to working within the RoW • All staff and contractors will be trained in the awareness and management of all fauna including snakes • Finalise construction site plans, including: <ul style="list-style-type: none"> – Extent of the clearing works – Environmentally sensitive areas – Identification of 'no go' zones – Where necessary, fencing requirements – Microhabitats, including habitats trees to retained • Stored fill will not be placed in areas where clearing of vegetation significantly isolates, fragments or dissects tracks of vegetation resulting in a reduction of ecosystem function. Fill is not to be placed in discharge areas. • Where clearing of remnant vegetation is required, clearing shall not exceed ten (10) metres in width for the purposes of establishing a track or twenty (20) metres for establishing a dual carriage road unless otherwise approved by the administering authority in writing

Item	Detail
	<p>Construction phase</p> <p><i>Vegetation clearing</i></p> <p>Prior to clearing activities beginning, detailed ecological surveys will be undertaken along the entire length of the GTP ROW as well as any ancillary areas in accordance with conditions 5 to 10 of the EPBC Act approval. As a minimum, these surveys will target listed threatened species, migratory species and their habitats as well as ecological communities under the EPBC Act and NC Act. Ground truthing of remnant communities listed under the VM Act will also be undertaken at this time to determine any discrepancies in state mapping which may in turn also apply to Commonwealth listed communities.</p> <p>For each listed species and ecological community likely to occur, surveys will be undertaken in accordance with relevant Commonwealth and State survey guidelines and best practice in effect at the time of each survey.</p> <p>All ecological surveys will be undertaken by suitably qualified ecologists who are approved by the Commonwealth prior to the survey period.</p> <p>Upon completion of the ecological surveys, a report detailing the survey methodologies and the field results will be provided to the relevant State and Commonwealth agencies and additionally published on the GLNG website. This report will also include the potential impacts to the ecological communities, listed species, and habitat of listed species as a result of clearing activities along with a quantification of the impacts. To meet the requirements of conditions 3b and 3c of the EPBC Referral Approval (2008/4096), it should be noted that specific measures will be undertaken to manage the impact of clearing on each listed threatened and migratory species and each ecological community as per the approved SSMP.</p> <ul style="list-style-type: none"> • No clearing of protected vegetation for field development will occur until appropriate permits have been obtained • Clearing will be limited to the minimum area practicable. The following are examples of how this can be achieved: <ul style="list-style-type: none"> – Having defined limits on the clearing plan – Identification of areas where clearing is restricted – Demarcation of “no go” areas – Implementing access control • A program to implement offsetting of cleared vegetation communities will be undertaken as required, in accordance with legislative criteria for the offsetting of significant vegetation communities. A biodiversity offset strategy and management plan will be developed • The location of vegetation to be retained will be clearly indicated on all construction drawings • Prior to the initialisation of works, the location of roads, site offices, stockpiling/laydown areas and plant and equipment storage areas (including heavy machinery) will be demarcated on site plans. The Contractor shall ensure that such areas are located on existing cleared lands which are: <ul style="list-style-type: none"> – At least 100 m from mapped wetlands and watercourses – Outside of the intertidal zone or >200 m from the mapped roosting areas (migratory species) or Category A ESAs – At least 50 m away from the EPBC Act listed ecological communities (as per SSMP) • Flagging of clearing boundaries through areas of significant vegetation will be completed during the pre-construction pegging of the pipeline alignment • A pre-construction vegetation survey will be completed in targeted areas of the RoW to identify for flagging individual EVR species and trees that contain hollows that may be avoided during construction • Ensure ‘no go zones’ are clearly sign-posted/ delineated on site prior to the commencement of works. The relevant EO will ensure that the clearing footprint and all ‘no go’ zones are adequately marked out for the clearing crew

Item	Detail
	<ul style="list-style-type: none"> • Areas of vegetation to be cleared will be restricted to the minimum width • All vegetation clearing will be confined to the RoW unless relevant permits and/or licenses have been approved. Any unauthorised clearing will incur an immediate stop work and a rehabilitation plan will be developed and approved by GLNG prior to commencing that activity again. The rehabilitation plan will include timeframes • Access tracks, laydown areas and other associated clearing will be placed outside of significant RE areas • With the exception of the RoW clearing requirements, clearing of remnant vegetation will not exceed ten (10) m in width for the purposes of establishing tracks and 20 m in width for dual carriageway roads unless otherwise approved by the administering authority in writing • Clearing of all remnant REs will be avoided where possible. However, where unavoidable, areas to be cleared will be clearly delineated, prior to the commencement of clearing activities • Physical barriers will be installed around significant vegetation areas in order to restrict access and avoid disturbance • Any vegetation clearing in an Endangered/Of Concern RE or associated 200 m buffer zone must not exceed any of the following areas: <ul style="list-style-type: none"> - 10 percent of the remnant unit of Endangered/Of Concern RE as ground truthed and mapped before an activity commences as per section D1 and D2 of the Coordinator General Report for the Project - 6 m in width for tracks and ten (10) m in width on corners, or - 30 m in width for pipeline construction purposes • Clearing within an Endangered and/or Of Concern Regional Ecosystem (RE) and its 200 m buffer zone, clearing will be according to the following order of preference: <ul style="list-style-type: none"> - Pre-existing cleared areas or significantly disturbed areas less than 200 m from an Endangered/Of Concern RE - Undisturbed areas less than 200 m from an Endangered/Of Concern RE - Pre-existing areas of significant disturbance within an Endangered/Of Concern RE (e.g. areas where significant clearing or thinning has been undertaken within a RE, and/or areas containing high densities of weed or pest species which has inhibited re-colonisation of native regrowth) - Areas where clearing of an Endangered/Of Concern REs is unavoidable • Details of any significant disturbance to land in or within 200 m of Endangered or Of Concern will be kept and submitted to the Proponent upon request • The clearing of any threatened ecological communities will be undertaken in accordance with any approval conditions issued by the DSEWPC, DERM and/or relevant regional councils

Item	Detail
	<ul style="list-style-type: none"> • Clearing and disturbance in riparian areas will be minimised to that necessary to safely construct the pipelines and meet other environmental requirements (eg separation of stock piles, erosion control) and will be controlled by: <ul style="list-style-type: none"> – Education of all personnel on procedures for working in these environments – Reviewing and accepting detailed procedures to be submitted prior to commencing these activities – Continuous monitoring of these sensitive operations to ensure compliance with the procedures • To ensure clearing and disturbance is minimised in riparian areas, activities will be undertaken in accordance with the Aquatic Values Management Plan (AVMP), which contains an Aquatic Values Assessment with detailed descriptions of each watercourse. The AVMP also details management procedures, including: <ul style="list-style-type: none"> – Disturbance area for each crossing – Construction methodology for crossing of watercourses – Equipment to be used during construction in either wet or dry conditions – Restrictions on timing of construction works – Methodology for dealing with stream flows during construction – Bank reinstatement materials – Mitigation measures such as erosion and sediment control plans • To ensure clearing and disturbance in riparian areas is minimised, crossing locations have been selected to utilise, where possible, areas of watercourses that have already been substantially cleared or are degraded (e.g. due to cattle access) • Locations close to permanent standing or flowing water where watercourses are ephemeral will be avoided to minimise disturbance in riparian areas. • The relevant EO will coordinate with the spotter catchers and construction team during clearing activities • Where habitat is to be cleared, appropriate mitigation measures will be implemented including adopting a protocol to ensure that appropriately licensed (DERM approved) and experienced spotter catchers are onsite during all clearing of identified at risk fauna areas • Clearing will be conducted in a sequential manner and in a way that directs escaping wildlife away from the activity and into adjacent natural areas • Minimise the clearing of mature and hollow bearing trees. Removal of nests and other breeding sites will be conducted in accordance with approval conditions under the NC Act and/or the EPBC Act • Due to the selective nature of Gliders and their food resources, Glider feeder trees will be retained wherever possible • Cleared native vegetation and timber will be respread over the RoW to aid regeneration and provide fauna habitat (subject to landholder agreement) • The natural regeneration of native species will be encouraged (in particular, groundcover and shrub species). However, seeding will be utilised in areas where rapid restoration is required (eg watercourse crossings and areas of high erosion potential). • Wetlands will be regenerated naturally. This will be achieved through regular weed control, maintaining existing tidal regimes, and mitigating issues with ASS. • Cleared native vegetation and timber will be stacked in piles and/or respread over the RoW to provide fauna habitat and assist revegetation (subject to landholder agreement). A “no burning” policy will be implemented • In areas that will be subject to significant disturbance the following in relation to soil is to occur: <ul style="list-style-type: none"> – The top layer of the soil profile is to be removed • Cleared vegetation will be stockpiled for resspreading during rehabilitation • A return of operations form will be sent to the Proponent immediately after clearing activities are completed or if the NC Act clearing permit ceases to have effect. This document will include all details of the clearing outcomes

Item	Detail
	<ul style="list-style-type: none"> Collection of local provenance seed from the listed communities will be carried out prior to the commencement of clearing activities throughout the time between contract award and commencing clearing. Seed collection will be undertaken as per the Seed Collection Plan and in accordance with seed collection guideline document: <i>Model Code of Practice, Florabank Guideline 6: Native Seed Collection Methods</i>, Available at http://www.florabank.org.au/ 5 Feb 2012' In the event of a non-compliance, the Contractor will issue a "stop work" order, upon which all work will cease until the non-compliance has been rectified and measures implemented to prevent the breach re-occurring
	<p><i>Conservation and commercially significant flora</i></p> <ul style="list-style-type: none"> A pre-construction vegetation survey will be completed in targeted areas of the RoW to identify for flagging individual EVR species and trees that contain hollows that may be avoided during construction Where avoidance is not possible, the loss of EVR environmental values will be offset in accordance with the requirement of the biodiversity offset strategy A biodiversity offset strategy and management plan will be developed and implemented for significant vegetation communities over an appropriate time frame to accomplish the following specific aims: <ul style="list-style-type: none"> Identification of suitable potential offset areas with ecological values analogous to impacted ecological communities Assessment of the ecological value and equivalence of offsets to ensure suitable offset extent, species assemblage, floristic structure and ecological integrity utilising an appropriate biometric field methodology (DERM's ecological equivalence method) Development of appropriate management prescriptions to ensure long term viability of offsets (such as pest control, livestock management, access exclusion, ameliorative plantings and fire regime management) Placement of appropriate covenants for future conservation and management of offsets Development of appropriate monitoring and maintenance activities and performance review processes to ensure long term viability of the offsets The process of developing a suitable biodiversity offset management plan will be an iterative process with State and Commonwealth regulatory bodies The route has been selected to avoid disturbance to endangered and vulnerable flora species as far as possible and to minimise fragmentation and habitat disturbance of protected fauna species For species listed under the provisions of the NC Act, and species identified as critical and high priority under the DERM Back on Track species prioritisation methodology, a SSMP will be developed and will detail specific measures for the mitigation of all impacts and will be provided to GLNG Operations prior to construction. Specific measures will be included in the plan for the mitigation of any disturbed <i>Cycas megacarpa</i> including potential options for propagation or translocation The Contractor is responsible for including within its SSMP, details to ensure the following measures for Type A Restricted Least Concern Plants (Schedule 7 of the <i>Nature Conservation (Administration) Regulation 2006</i>) are implemented in order of preference: <ul style="list-style-type: none"> Avoid clearing individual species wherever possible (eg edge of RoW) Salvage and reuse for on-site revegetation where practicable Salvage and reuse for local area revegetation where practicable Collect seed of non-translocatable species for use in on-site revegetation where practicable Use of seed for rehabilitation purposes (refer LRMP) Commercial salvage The SSMP is to be submitted to DERM for approval prior to commencing construction. Type A Restricted Plants includes species in the Family: <i>Cycadaceae</i>, <i>Orchidaceae</i>, and <i>Zamiaceae</i>; and species in the genus: <i>Brachychiton</i>; <i>Hydnophytum</i>; <i>Huperzia</i>; <i>Livistona</i>; <i>Myrmecodia</i>; <i>Platyserium</i>; and <i>Xanthorrhoea</i> Flagging of clearing boundaries though areas of significant vegetation will be completed during the pre-construction pegging of the pipeline alignment

Item	Detail
	<ul style="list-style-type: none"> • The clearing of any threatened ecological communities will be undertaken in accordance with any approval conditions issued by the DSEWPC, DERM and/or relevant regional councils (this will be particularly relevant because of fauna habitat that may be associated with the community) <p><i>Dust impacts on adjacent vegetation</i></p> <ul style="list-style-type: none"> • No excessive dust emissions during construction of the pipeline <p><i>Weeds</i></p> <ul style="list-style-type: none"> • A Pest and weed management plan will be prepared in accordance with: <ul style="list-style-type: none"> - Each of the respective Regional Council's weed and pest animal management plans - The <i>Land Protection (Pest and Stock Route Management) Act 2002</i>, which governs actions with respect to the control and management of declared plants and animals in the state - The requirements of relevant weed management officers of the Department of Employment, Economic Development and Innovation (DEEDI) (formally Primary Industries and Fisheries) and the relevant local councils - Biosecurity Queensland's Annual Pest Distribution Survey 2008 data and predictive pest maps available on the DEEDI website: http://www.dpi.qln.gov.au/cps/rde/dpi/hs.xml/4790_9827_ENA_HTML.htm; and - Queensland Herbarium naturalised flora data • The Contractor will prepare a Weed and Pest Management Plan to minimise the risk of weed and pest species establishing within and adjacent to the RoW. The PWMP will be in accordance with GLNG Operations PWMP and shall specifically address: <ul style="list-style-type: none"> - The prevention and management of weed disturbance to <i>Cycas megacarpa</i> - The prevention and management of weed disturbance to significant ecological communities - The prevention and management of feral fauna species on Fitzroy River Turtle habitat and mapped migratory bird roosting sites - The prevention and management of feral fauna species on significant ecological communities • Control programs will be prioritised to high risk areas adjacent to land of conservation significance • Following rehabilitation, weed survey and control will be incorporated into the monitoring plan • Weed inspection of the RoW will be completed prior to construction and the location of declared plants and other weeds recorded • The weed control program will consist of the following strategies: <ul style="list-style-type: none"> - Vehicle and equipment washdowns - Record keeping - Close monitoring - Spraying - Vehicle stickers - Training - Management of vehicle movements <p><i>Edge effects</i></p> <ul style="list-style-type: none"> • Access roads to the RoW will be defined to minimise the potential for the spread of weed species and protocols established for washdown of vehicles travelling along the RoW <p><i>Fire</i></p> <ul style="list-style-type: none"> • Minimise fire risk through evaluation processes and management of those risks • Restrict high-risk activities in accordance with local fire bans or in times of high fire danger • Maintain a plan for rapid and co-ordinated response to the outbreak of fire through an established fire response plan in conjunction with the local metropolitan and rural fire brigades

Item	Detail
	<ul style="list-style-type: none"> • Conduct fire safety awareness training as part of site inductions • Adhere to fire bans • Maintain fire fighting equipment at all hot work sites. • The following precautions will be taken to minimise the possibility of fire due to welding activities: <ul style="list-style-type: none"> – The construction area along the RoW (other than the designated stockpile areas) will be cleared of combustible vegetation to reduce the risk of fire – Stockpiled vegetation will be separated from welding activity – Water trucks (also used for dust suppression) will be available for use as fire trucks in the event of fire <p><i>Erosion and sedimentation</i></p> <ul style="list-style-type: none"> • Clearing slopes leading to watercourses will be delayed, where practicable, until construction of the crossing is imminent, or alternative measures are employed to prevent and/or minimise erosion and sedimentation risk • Implement measures outlined in the erosion and sediment control plan <p><i>Loss of habitat</i></p> <ul style="list-style-type: none"> • Where there is a reasonable loss of hollow trees nesting boxes will be installed • Where habitat is to be cleared, appropriate mitigation measures will be implemented including adopting a protocol to ensure that appropriately licensed (DERM approved) and experienced spotter catchers are onsite during all clearing of identified at risk fauna areas • If suitable habitat for Squatter pigeons is located during the pre-clearing surveys and construction activities occur within the breeding/nesting periods, an appropriately experienced professional/Ecologist will actively search the known/mapped habitat area(s) for this species approximately 2 weeks prior to clearing activities beginning. If active nests are located, measures set out in the SSMP must be followed • Clearing will be conducted in a sequential manner and in a way that directs escaping wildlife away from the activity and into adjacent natural areas • Minimise the clearing of mature and hollow bearing trees. • Due to the selective nature of Gliders and their food resources, Glider feeder trees will be retained wherever possible • Where habitat trees need to be removed the following measures will be implemented: <ul style="list-style-type: none"> – Where habitat trees cannot be retained and are adjacent to areas of bush, the portion of the limb that supports the hollow shall be removed and relocated in adjoining remnant vegetation, either affixed to a tree (for hollow bearing branches) or on the ground (for hollow bearing logs) – Habitat trees will be shaken with the blade of the machine – Fauna found occupying tree hollows will be relocated into suitable available hollows or nesting boxes within adjacent vegetation. – The suitability of adjacent vegetation for relocation will be determined on the basis of expert ecological opinion – An accredited spotter-catcher will be engaged during clearing and trenching activities • Timber should be stacked in piles to provide fauna habitat and assist revegetation (subject to landholder agreement). A no burning policy will be implemented <p><i>Fragmentation and loss of fauna movement opportunities</i></p> <ul style="list-style-type: none"> • Vegetation clearing will be restricted to the minimum width required • The LRMP will include measures to facilitate fauna movement, including: <ul style="list-style-type: none"> – Habitat features, such as rocks and large woody debris, that needs to be cleared will be retained and relocated into the RoW following construction to provide stepping stones and microhabitats for fauna – Large woody debris, rocks and other microhabitats within the RoW to be relocated to accommodate fauna

Item	Detail
	<p><i>Fauna management</i></p> <ul style="list-style-type: none"> • Fauna Management Procedures will be developed as part of the Construction EM Plan, and be made available to GLNG as requested and will detail all fauna mitigation measures • A pre-construction vegetation survey will be completed in targeted areas of the RoW to identify for flagging individual EVR species and trees that contain hollows that may be avoided during construction • Minimising the clearing of mature and hollow-bearing trees • Minimising the length of time the trench is open through the staging of activities • Temporary exclusion fencing where practicable to restrict fauna access to the trench • The use of night caps over open pipe string ends to prevent the ingress of wildlife • Pipes being strung with adequate gaps or selective backfilling to allow for fauna movement across the line of the pipe • During construction, the entire length of the RoW will be regularly inspected to assess the effectiveness of protection measures, with particular attention to areas such as soils segregation, erosion control devices, fauna escape ramps and access across the easement • Installation of ramps and trench plugs with a slope less than 50 per cent at least every 1000 m to assist fauna to leave the trench • Installation of shelter material to provide wet weather protection and reduction of heat stress, such as by placing sawdust filled Hessian bags in pairs every 250 m • A copy of the fauna management procedures will be made available to the administering authority on request • The open trench will be checked by appropriately trained personnel for trapped fauna at least twice daily (early morning/late afternoon). <p><i>Environmental Offsets</i></p> <ul style="list-style-type: none"> • Offsets will be provided for the permanent loss (take) of near threatened, rare, vulnerable and endangered plants in accordance with the Queensland Government Environmental Offsets Policy 2008 and generally in accordance with the Queensland Government Policy for Biodiversity Offsets (Consultation Draft). Details of proposed environmental offsets consistent with the Queensland Government Environmental Offset Policy 2008 and specific issue policies are to be provided upon request • An Environment Offsets Program, consistent with the Queensland Government Environmental Offset Policy 2008 and specific issue policies will be provided for approval to the Coordinator-General prior to environmental authorities being issued covering gas field development, pipeline construction and LNG facility construction and operation • The offset program will detail: <ul style="list-style-type: none"> – The principles adopted for the environmental offsets strategy – The predicted total loss (extent and type) of areas of ecological value, (e.g. remnant vegetation, high value regrowth, wetlands, significant conservation species, habitat, biodiversity corridors) which, for the listed species and communities and essential habitats, shall be no greater than the areas specified for each item in the tables of section 6.5 of the Coordinator-General's report and corresponding tables in the Proponent's SEIS, with appropriate allowances for reductions due to co-location of species within habitats and ecosystems – The procedure to identify the requirements for environmental offsets for specific components of the project over the life of the project – Relevance to any legislative requirements for offsets – The mechanism to secure and manage the environmental offset for long term protection of values – The location, size and values of the offsets – Any management measures, including funding, required to maintain or enhance values for the life of the offset – A system for reporting to the Coordinator-General on offset arrangements, their management and how offset values are being maintained

Item	Detail
	<p><i>Conservation significant fauna species</i></p> <ul style="list-style-type: none"> • Fauna Management Procedures will be developed as part of the Construction EM Plan, and be made available to the GLNG as requested and will detail all fauna mitigation measures • A pre-construction vegetation survey will be completed in targeted areas of the RoW to identify for flagging individual EVNT species and trees that contain hollows that may be avoided during construction • Pre-construction surveys must identify koala habitat as defined under the Nature Conservation (Koala) Conservation Plan 2006 and any specific mitigation measures must be identified and implemented • Where roads traverse suitable koala habitat (RE12.3.3), fence design will incorporate the need to allow movement of koalas and other fauna species • Expert advice will be sought to assist in identifying the need and location of crossing points for gliders and other arboreal species (eg Koalas) • Liaison with wildlife rescue organisations or individuals • For species listed under the provisions of the NC Act, and species identified as critical and high priority under the DERM Back on Track species prioritisation methodology, a Significant Species Management Plan (SSMP) will be developed and detail specific measures for the mitigation of all impacts and will be provided to the Proponent prior to construction • If significant fauna species are located within the RoW and cannot be avoided, individuals will, where practicable, be relocated using measures outlined as follows: <ul style="list-style-type: none"> - Individuals should be collected by a suitably licensed and experienced spotter catcher and placed in an appropriate container/bag for relocation - Individuals should be relocated to a location nearby providing similar habitat appropriate for that species - Numbers and location of individuals relocated must be recorded for reporting purposes - Hygiene protocols must be implemented and adhered to (eg measures for control of chytrid fungus which is a known pathogen of frogs) - The time taken for relocation must, where practicable, be kept to a minimum to minimise stress to the animal. A report outlining the potential relocation must be submitted to the DERM and QPIF prior to the commencement of construction activities • Where avoidance is not possible, the loss of EVNT species and environmental values will be offset in accordance with the requirement of the biodiversity offset strategy • Prior to commencement of construction, a species management plan for affected fauna, regardless of status (both terrestrial and marine) will be prepared in consultation with DERM for the total project including, development, operation and decommissioning phases. The plan must satisfy the requirements under section 322 of the <i>Nature Conservation (Wildlife Management) Regulation 2006</i> relating to tampering with animal breeding places. The plan will be developed to: <ul style="list-style-type: none"> - Address the impacts to the species - Provide for the survival of the species in the wild • The Contractor is responsible for developing a Species Management Plan (SMP) for affected fauna, regardless of status. The plan will be in accordance with the GLNG Operations SMP <p><i>Fauna injury and mortality</i></p> <ul style="list-style-type: none"> • Where habitat is to be cleared, appropriate mitigation measures will be implemented including adopting a protocol to ensure that appropriately licensed (DERM approved) and experienced spotter catchers are onsite during all clearing of identified at risk fauna areas

Item	Detail
	<ul style="list-style-type: none"> • Training staff in the awareness of environmental issues must include at least: <ul style="list-style-type: none"> – The environmental policy of The Company and the Contractor; – Any relevant environmental objectives and targets; – Control procedures to be implemented for routine operations for day to day activities to minimise the likelihood of environmental harm, however occasioned or caused; – Contingency plans and emergency procedures to be implemented for non-routine situations to deal with foreseeable risks and hazards, including corrective responses to prevent and mitigate environmental harm (including any necessary site rehabilitation) – Organisational structure and responsibility to ensure that roles, responsibilities and authorities are appropriately defined to ensure effective management of environmental issues – Effective communication procedures to ensure two-way communication on environmental matters between operational staff and higher management – Obligations with respect to monitoring, notification and record • Details of all surveys, fauna removal and relocation activities undertaken during construction of the Mainland GTP will be recorded in accordance with the SSMP, SMP and fauna management procedures • Traffic speeds to be limited in areas of high habitat value or known movement corridors, especially during dusk and dawn • Any animals injured by clearing activities will be referred to an appropriate wildlife carer group or veterinarian. DERM must also be notified within 24 hours of any injuries or deaths • If significant fauna species are located within the RoW and can not be avoided, individuals will, where practicable, be relocated using measures outlined as follows: <ul style="list-style-type: none"> – Individuals should be collected by a suitably licensed and experienced spotter catcher and placed in an appropriate container/bag for relocation – Individuals should be relocated to a location nearby providing similar habitat appropriate for that species – Numbers and location of individuals relocated must be recorded for reporting purposes – Hygiene protocols must be implemented and adhered to (eg measures for control of chytrid fungus) – The time taken for relocation must, where practicable, be kept to a minimum to minimise stress to the animal. A report outlining the potential relocation must be submitted to the DERM and QPIF prior to the commencement of construction activities • Removal of nests and other breeding sites will be conducted in accordance with approval conditions under the NC Act and/or the EPBC Act • Where practicable, watercourse crossings shall be scheduled during dry or low flow periods to avoid periods of fauna sensitivity. Consideration of tidally influenced waters shall also be required • Appropriately licensed and experienced spotter-catchers should assess the clearing footprint (in sequential sections) up to 2 weeks prior to clearing works beginning. This will include but not be limited to checking tree hollows prior to clearing for hollow-dependent fauna • Where constructability allows, micrositing or selective clearing to avoid habitat trees (inc hollow bearing trees) and other microhabitats identified during the pre-clearing surveys • Authorised fauna spotters must be present when clearing in areas identified as having moderate or high likelihood of arboreal mammals and/or tree nesting birds, as required by the EM Plan • Barbed wire fences will not be used within the RoW as these can cause mortality in bat, glider and bird populations. However, if the landholder requests a barb wire fence to be constructed, the top strand will be high tensile steel (non-barbed wire) to avoid fauna getting caught and tangled in the barbs • Clearing will be conducted in a sequential manner and in a way that directs escaping wildlife away from the activity and into adjacent natural areas

Item	Detail
	<ul style="list-style-type: none"> • Any animals injured by clearing activities will be referred to an appropriate wildlife carer group or veterinarian. DERM must also be notified within 24 hours of any injuries or deaths • Where habitat is to be cleared, appropriate mitigation measures will be implemented including adopting a protocol to ensure that appropriately licensed (DERM approved) and experienced spotter catchers are onsite during all clearing of identified at risk fauna areas • Where practicable, temporary exclusion fencing to restrict fauna access to the trench will be installed • The following measures will be adopted to prevent fauna entrapment within the pipeline trench, such as: <ul style="list-style-type: none"> – Trenching will occur progressively to minimise the period of time the trench is open, particularly in key habitat areas – Fauna escape ramps of a slope less than 50% or trench plugs will be placed at least every 1000 m along any open trench – In areas of known or high habitat value additional ramps, trench plugs branches and hessian bags for shelter will be placed within the trench at greater than normal frequencies – Branches, hessian sacks, ramped gangplanks or similar to be used to create 'ladders' to enable fauna to exit the trench. These will be provided as a minimum every 250 m – Water-soaked, sawdust filled hessian sacks (used to support pipes prior to lay-in) will be placed every 250 m along the open trench to harbour fauna that may become trapped in the open trench – It may be necessary to use additional devices to remove fauna from the trench due to OH&S issues. This may include nets or mesh in conjunction with shelter which can be extracted via ropes, placement of branches or ropes which fauna can scale. Contractor is to submit a plan detailing how this activity is to occur and will cover all foreseeable problems prior to construction • When an animal is noted as trapped, work in the immediate vicinity (ie 50 m) to stop immediately and the site supervisor notified • Fauna trapped in trenches should be removed as soon as possible by a suitably qualified person. No operations are to commence or continue within the immediate vicinity until fauna have been removed • Landowner/owner will be immediately notified of trapped domestic species. These animals will then only be removed in collaboration with the landowner/owner, under direction of The Company • It may be necessary to use additional devices to remove fauna from the trench due to OH&S issues. This may include nets or mesh in conjunction with shelter which can be extracted via ropes, placement of branches or ropes which fauna can scale. Contractor is to submit a plan detailing how this activity is to occur and will cover all foreseeable problems prior to construction • Vehicle and pedestrian access to and from the RoW will be restricted to the defined access tracks • Appropriate signage to be erected near sensitive habitats or nesting areas • If practicable, the water intake pipes must include an effective screen or a similar device to prevent aquatic and semi-aquatic species from entering the pipe for the duration of the pipeline usage • All waste/rubbish will be correctly disposed of and will not pose a risk to fauna. Plastic bags will be banned from all site offices and project areas within the coastal zone <p><i>Pests</i></p> <ul style="list-style-type: none"> • A Pest and Weed Management Plan (PWMP) will minimise the risk of weed and pest species establishing within and adjacent to the RoW. The PWMP shall specifically address: <ul style="list-style-type: none"> – The prevention and management of weed disturbance to <i>Cycas megacarpa</i> – The prevention and management of weed disturbance to significant ecological communities – The prevention and management of feral fauna species on Fitzroy River Turtle habitat and mapped migratory bird roosting sites – The prevention and management of feral fauna species on significant ecological communities • Ensure that all food scraps and other waste material is correctly disposed of and stored in appropriate containers to prevent pest and other fauna from access

Item	Detail
	<p><i>Feral Animals</i></p> <ul style="list-style-type: none"> • Fauna exclusion fencing to be utilised where necessary • If required, recommended active control methods include baiting, trapping, ground shooting and den fumigation • Fencing is recommended to keep cane toads out of ponds intended for native fish and frogs <p><i>Lighting</i></p> <ul style="list-style-type: none"> • Lighting for Work related activities will comply with the Occupational Health and Safety (OSH) guidelines to minimise where practicable light spill on marine fauna • Identify any light-sensitive areas (eg intertidal areas of Port Curtis which are known roosting sites for migratory birds) and only install lighting where necessary and that complies with the Occupational Health and Safety guidelines to minimise light spill on any light-sensitive environments • Direct temporary lighting away from light-sensitive areas. Light shades and low lighting must be applied to construction and operational areas located adjacent to remnant native vegetation and other environmentally sensitive areas • Where a listed migratory species roosting area or route is identified, working hours will be restricted to daylight hours, as far as practicable • Visual barriers between the construction site and the identified roost areas will be erected to minimise disturbance to migratory birds. The design and erection of the barriers should be undertaken in consultation with both GLNG Operations and ecological specialists
<p>Performance Indicators</p>	<ul style="list-style-type: none"> • Minimal disturbance of terrestrial flora and fauna during construction of the pipeline, associated tracks, services and accommodation facilities • No unplanned or unapproved damage to flora and fauna • No spread of weeds and compliant with the Weed Management Plan or CEMP • No new weed infestation in the RoW as a result of construction or operational activities. • Soils and vegetation stored appropriately to allow for restoration of disturbed areas to equivalent to surrounding area after construction • As a vehicle passes into a new zone (clean or dirty), a new sticker must be administered

10. Noise

10.1 Chapter summary

This section provides a summary of the noise and vibration emissions assessment associated with the construction of the Mainland GTP RoW as well as proposed management plans to minimise impacts.

For noise and vibration purposes, the following construction activities have been assessed for the Mainland GTP:

- Ship unloading at Port Alma
- Ship unloading at Gladstone Port (Lot 300)
- Road transportation of pipe elements
- General construction activities associated with Mainland GTP RoW
- Construction and operation of construction camps
- Blasting

10.1.1 Summary of existing noise values

A summary of the existing noise values along the Mainland GTP RoW is provided below:

- The majority of the Mainland GTP RoW will traverse rural farming and grazing land, and the RoW is generally a number of kilometres from populated centres and rural residences
- All identified sensitive and commercial receptors within 4 km of the Mainland GTP RoW are presented in Appendix H2 and shown graphically in Appendix H1. Identified industrial receptors (only relevant at vibration sensitive places) are presented in Appendix H3
- Noise from ships docking and unloading at the ports is already part of the existing noise environment at the eastern end of the Mainland GTP
- Ambient background noise levels along the Mainland GTP RoW are generally typical for rural farming and grazing land with low ambient background noise levels (below 25 dBA) dominated by animal noise, and particularly insects. Insect noise is seasonal, and generally is not present during the winter months
- Summaries of recent attended ambient background noise measurements, and previous unattended and attended noise monitoring along the Mainland GTP RoW are provided in Table 10.2 and Table 10.3 respectively

10.1.2 Summary of potential noise impacts

Construction

The construction of Mainland GTP RoW is expected to generate noise and vibration emissions associated with construction traffic, unloading at the ports and general construction activities associated with Mainland GTP RoW (ie clear and grade, excavation, stringing and bending, rockbreaking, compacting rollers and heavy vehicle movements, construction and operation of construction camps).

All activities and works associated with construction of the Mainland GTP RoW, road transportation of pipe elements, construction and operation of construction camps, blasting and unloading at the ports will be undertaken in accordance with the control strategies as outlined in Section 10.8 to minimise potential noise and vibration impacts from construction activities. Additionally, ship unloading and re-loading associated with the Mainland GTP will not change or deviate from those activities currently being carried out in the port area.

Operation

Regular inspections will be carried out along the Mainland GTP RoW by vehicle and foot patrols to check on the condition of the GTP and associated infrastructure. Typically maintenance on the Mainland GTP RoW will be carried out by light vehicles and small maintenance crews when required.

Noise emissions from these operational activities are expected to be low and manageable due to the low number of vehicles movements, infrequent maintenance activities and long separation distances from the Mainland GTP RoW to the sensitive receptors.

Furthermore, all activities and works associated with these operational activities will be in accordance with the Operational Management Plan (OMP) which will be developed and implemented prior to the completion of the construction phase.

10.1.3 Summary of proposed noise management measures

Table 10.1 Environmental protection commitments, objectives and control strategies – noise

Item	Detail
Environmental Protection Objective	<ul style="list-style-type: none"> To construct the GTP in a manner to minimise the impact of construction related noise and vibrations on surrounding residences and industry
Specific Objectives	<ul style="list-style-type: none"> Compliance with licence conditions and industry standards No warranted complaints from residents and landholders, and warranted complaints responded to within 2 working days Blasting activities will meet the applicable Australian Standards and statutory requirements
Control Strategies	<ul style="list-style-type: none"> Refer to Table 10.27 for noise and vibration management control strategies to be implemented during construction and operation of the Mainland GTP
Performance Indicators	<ul style="list-style-type: none"> No warranted complaints from residents and landholders, and warranted complained responded to within 2 working days Compliance with licence conditions and industry standards Blasting activities will meet the applicable Australian Standards and statutory requirements

10.2 Existing noise environment

The majority of the Mainland GTP RoW will traverse rural farming and grazing land, and the RoW is generally a number of kilometres from populated centres and rural residences.

Studies of cadastral data and aerial photographs supported through site visits showed that land type along the Mainland GTP RoW can generally be categorised as rural. Properties at the western extremity of the RoW are generally cattle grazing, with farming becoming more common between Bauhinia and Biloela. There are coal mines near Moura and Biloela, and a limestone mine at East End near Mount Larcom. However, attended noise measurements and observations indicated that these did not contribute significantly to the existing ambient background noise levels at the measurement locations.

Summaries of recent attended ambient background noise measurements, and previous¹ unattended and attended noise monitoring along the Mainland GTP RoW are provided in Table 10.2 and Table 10.3 respectively. The locations of noise measurements provide spatial coverage of all identified receptors within the study area, and are shown graphically in Appendix H1.

Noise measurements carried out for the 2008 EIS study included unattended noise measurements over a minimum of 7 days, as well as attended noise measurements; while noise measurements in the current study were restricted to attended noise measurements only. Whilst short-term attended ambient noise measurements do not have the temporal scope of logger noise measurements they provide more detailed information on the noise sources in the area.

Table 10.3 presents the details of the attended ambient background noise measurements including measurement locations, time and date, measured noise levels, observations noted and comments made during measurements along with site photos.

All noise measurements were carried out using Type 1 sound level meters and noise loggers under current NATA calibration certification. All measurements, including field calibration checks were carried out in general accordance with AS 1055.1-1997 *Acoustics – Description and measurement of environmental noise – General procedures*.

The measured background noise levels and observations in the field were used to establish the background noise level for all identified receptors within a 4 km distance of the Mainland GTP RoW, as illustrated in Appendix H2.

It should be noted that the background noise levels presented are by definition representative of the lowest 10th percentile of background noise in an area (in accordance with DERM assessment guidelines). This would be during periods of little or no breeze (as encountered during the most recent attended noise measurements) and negligible insect activity (accounted for by filtering out insect noise from the results). Background noise levels in rural areas increase substantially with wind-induced vegetation noise and insect activity. This fact can't be relied upon to increase the project noise criteria, but will in practice mitigate noise impacts to a degree by masking some of the construction noise. The noise levels presented in Table 10.2 and Table 10.3 are for the LA_{90T} noise level, as noise limits are to be set by comparing with the existing background noise level measured by the LA_{90T} parameter.

Table 10.2 Unattended ambient background noise levels

Location ID	Measurement date	Site	Logger GPS coordinates	Rating background level (dBA)		
				Day (7am to 6pm)	Evening (6pm to 10pm)	Night (10pm to 7am)
P4	20 Feb to 6 Mar 2008	Yarwun (Mt Larcom Gladstone Rd, near Flynn Rd)	-23.840643° 151.108262°	41	40	37
P5	20 Feb to 6 Mar 2008	Near Bridge Crossing (Northern end of Flinders Rd)	-23.745427° 151.097502°	31 ³	31 ^{2,3}	33 ²

¹ SLR Consulting (Heggies) 20-2014R1R4 Santos Gladstone LNG Environmental Impact Statement Noise and Vibration (Terrestrial) dated 22 May 2009.
SLR Consulting (Heggies), ambient noise monitoring at Targinnie Road October 2010, unpublished.

Location ID	Measurement date	Site	Logger GPS coordinates	Rating background level (dBA)		
				Day (7am to 6pm)	Evening (6pm to 10pm)	Night (10pm to 7am)
GP3	16 June to 30 June 2008	Fairview Rd (~400m west of intersection with Beilba Rd)	-25.604078° 148.794973°	24	18 ¹	18 ¹
GP4	16 June to 30 June 2008	Carnarvon Hwy (~55km North of Injune)	-25.412463° 148.623078°	27	19 ¹	18 ¹
Winter's Property	12 Nov to 27 Nov 2008	Kaimanna	-25.405191° 148.864101°	23	18	18
GP5	16 June to 30 June 2008	Acadia Valley (Acadia Valley Rd)	-25.311035° 148.857967°	21 ¹	18 ¹	17 ¹
GP6	16 June to 30 June 2008	North of Banana (Baralaba Banana Rd, ~15km North of Banana)	-24.359955° 150.047449°	21 ¹	18 ^{1,2}	18 ¹
GP7	16 June to 30 June 2008	North of Biloela (Jambin Dakenba Rd, ~15km North of Biloela)	-24.272246° 150.453302°	29	27	27
GP8	16 June to 30 June 2008	West of Gladstone (Cnr of Mt Alma Rd & Kaluda Rd)	-23.970074° 150.966315°	29	21 ^{1,2}	18 ¹
GP9	15 July to 28 July 2008	Springwater Overseer's Cottage	-25.756953° 148.936257°	30	29	29
GP10	30 Sep to 6 Oct 2010	Targinnie Road, Targinnie	-23.789093° 151.108219°	29	35	30

Note 1: Adjusted to account for the noise floor of logger (noise floor is described as the minimum noise level to which noise logger can record noise). Corrections to account for noise floor of logger are based on analysis of logger results, attended measurements and field observations.

2: Adjusted to correct for enhanced noise levels as a result of insect noise

3: Adjusted to correct for elevated wind levels and increased noise levels due to movement of trees

4: Adjusted to correct for elevated wind levels and increased noise levels due to lapping of harbour waves

Table 10.3 Attended ambient background measurements

Loc. ID	Monitoring location GPS coordinates	Date	Time (end of 15 min period)	LA90	Observations and comments
P4	-23.840643° 151.108262°	06/03/08	4:45pm	51	Industrial noise audible; occasional traffic on Mt Larcom – Gladstone Rd; insects dominant at times; occasional birds; tree movement
		05/03/08	8:30pm	41	Insects dominant noise; distant industrial noise audible; occasional traffic on Mt Larcom – Gladstone Rd; low tree movement
		05/03/08	11:45pm	40	Insects and distant industrial noise dominant noise sources
P5	-23.745427° 151.097502°	06/03/08	3:15pm	45	Insect and birds noise audible; tree movement
		05/03/08	7:15pm	50	Insects dominant noise source; tree movement
		06/03/08	10:45pm	41	Insects dominant noise source; distant industry noise just audible; tree movement

Loc. ID	Monitoring location GPS coordinates	Date	Time (end of 15 min period)	LA90	Observations and comments
GP3	-25.604078° 148.794973°	17/06/08	12:45pm	27	Birds active and dominant; minor insect noise; truck pass-by on Fairview Rd (55 to 65 dBA); light tree movement with breeze
		-	-	-	No evening attended measurement due to safety of site access at night
		-	-	-	No night attended measurement due to safety of site access at night
GP4	-25.412463° 148.623078°	17/06/08	17:45pm	26	Birds, insects and cow noise dominant noise sources. Distance traffic just audible (trucks ~ 35 dBA)
		17/06/08	6:15pm	19	Insect, bird and cow noise all dominant though not loud; distant traffic on Carnarvon Hwy audible (truck ~ 35 to 40 dBA, car ~25 to 32 dBA)
		-	-	-	No night attended measurement due to safety of site access at night
GP5	-25.311035° 148.857967°	17/06/08	3:15pm	21	Insects and birds dominant; light tree movement in breeze; 4WD drove by on dirt road (45 to 47 dBA over 15 seconds)
		-	-	-	No evening attended measurement due to safety of site access at night
		-	-	-	No night attended measurement due to safety of site access at night
GP6	-24.359955° 150.047449°	18/06/08	12:45pm	19	Bird and cow noise dominant; light tree movement in breeze; traffic pass-by on local road (40 to 45 dBA over ~20 seconds)
		18/06/08	9:30pm	25	Insects dominant (3.15 kHz dominant); distant cow and frog noise
		-	-	-	No night attended measurement due to safety of site access at night
GP7	-24.272246° 150.453302°	18/06/08	3:45pm	28	Insect and bird noise dominant; occasional car pass-by on local road (32 to 35 dBA); distant construction noise (road works ~500m) – just audible
		18/06/08	6:15pm	64	Insects loud and dominant (3.15 kHz dominant); occasional car pass-by on local road (didn't raise levels above insects)
		18/06/08	11:00pm	32	Insects dominant noise source; distant rail/industry noise to NE (coal mine) – low frequency noise
GP8	-23.970074° 150.966315°	19/06/08	12:45pm	26	Insects and birds dominant noise source; light tree movement in breeze; distant creaking of tin roof on house and shed in sun
		19/06/08	9:30pm	31	Insects dominant noise source; distant mechanical noise (pump); truck passing by on Mt Alma Rd (up to 45 dBA for ~30 to 45 sec)
		26/06/08	2:15am	17	Very quiet at this location; occasional frog noise; distant train movement just audible
GP9	-25.756953° 148.936257°	15/07/08	10:45am	28	Birds dominant, light tree movement. Passing 4WDs audible (~38 to 42 dBA), 5 pass-bys in 15 minute block. Distant construction noise from booster site
		-	-	-	No evening attended measurement due to safety of site access at night

Loc. ID	Monitoring location GPS coordinates	Date	Time (end of 15 min period)	LA90	Observations and comments
		-	-	-	No night attended measurement due to safety of site access at night
GP10	-23.789093° 151.108219°	5/10/10	4:45pm	≤25	Insects constant 35 dBA, f > 3150 Hz Birds 37 to 63 dBA Distant jet Distant car ~ 40 dBA Car pass-by 77 dBA (only car in 15 minutes)
		5/10/10	9:45pm	≤25	Insects and frogs constant 40 to 43 dBA, f > 1000 Hz Flying foxes. Distant low frequency noise. Possibly generator at residence or Yarwun alumina refinery. Faint sound of water running
		6/10/10	12:00am	≤25	Insects, birds and frogs constant 37 to 41 dBA, f > 2000 Hz Distant low frequency noise. A few flying foxes
GP11	-23.752284° 151.032928°	17/02/11	1:36pm	≤25	Measured near The Narrows Road, road reserve. Insects 60 to 63 dBA Expect LA90 <25 dBA in still weather and with no insects Some breeze in vegetation No other noise sources noted
GP12	-24.101460° 150.804048°	17/02/11	9:03pm	≤25	Measured near Dawson Highway, road reserve. Insects 47 to 48 dBA dominant Distant road traffic
GP13	-24.465714° 150.129161°	17/02/11	10:50pm	≤25	Dawson Highway, road reserve. Trucks on Dawson Hwy 47 to 52 dBA Trucks on Leichardt Hwy 71 to 72 dBA Insects dominant background noise Distant traffic on Dawson Hwy audible
GP14	-24.577787° 149.265213°	18/02/11	12:31am	≤25	Dawson Highway, road reserve. Insects dominant background noise Occasional noise from cattle
GP15	-24.555429° 149.299510°	18/02/11	7:14am	≤25	Measured near Bauhinia Community Sport Complex. Trucks on Dawson Hwy 32 to 33 dBA Distant aircraft Birds 40 to 45 dBA A few insects Distant cattle
GP16	-24.818462° 148.768333°	18/02/11	5:07pm	≤25	Measured near Arcadia Valley Road, road reserve. Distant tractor A few birds ~40 dBA Loud insects buzzing (fly) 35 dBA Cattle 39 to 47 dBA
GP17	-24.510332° 149.502445°	19/02/11	7:07am	≤25	Measured near Oombabeer Road, road reserve. Insects, distant agricultural machinery Distant aircraft 43

Loc. ID	Monitoring location GPS coordinates	Date	Time (end of 15 min period)	LA90	Observations and comments
GP18	-24.429647° 149.933586°	19/02/11	10:03am	≤25	Measured near Theodore-Baralaba Road (at intersection of Banana Mungi Road), road reserve. Some breeze in vegetation 34 dBA Birds 38 to 54 dBA Insects Utility truck driveby 74 dBA
GP19	-24.311512° 150.307124°	19/02/11	11:33am	≤25	Measured near Beldeen-Greycliffe Road, road reserve. Insect noise ~50 dBA A few birds Some breeze in trees ~42 dBA (when insects quiet) Distant agricultural machinery noise
GP20	-24.289236° 150.417398°	19/02/11	12:19pm	≤25	Measured near Burnett Highway, road reserve. 4x4 80 dBA Distant agricultural machinery noise Traffic on highway ~80 dBA (pass-by level) Some periods of no traffic Insects Some occasional breeze in vegetation Truck 86 dBA
GP21	-24.295264° 150.538561°	19/02/11	2:41pm	35	Measured near Grevells Road, road reserve Crow 51 dBA Some breeze in trees/crops Traffic on highway - not busy, but generally at least 1 car audible Estimate background without breeze ~25 to 30 dBA 4x4 pass-by (Grevells Road) 75 dBA No audible noise from mine
GP22	-24.021548° 150.970875°	20/02/11	11:45am	≤25	Measured near Calliope Station Road, road reserve. Birds 40 to 45 dBA Distant road traffic (Dawson Highway) Insects Car on road 55 dBA
GP23	-23.852182° 150.983288°	20/02/11	1:09pm	≤25	Measured near Picnic ground beside unnamed lagoon, East End. Insects Some breeze in vegetation Water birds 40 to 45 dBA Branch falling 60 dBA

Ambient sound in the area was dominated by animal noise, and particularly insects. Insect noise is seasonal, and generally is not present during the winter months. In order to obtain the ambient sound levels in the absence of insect noise, the measurements were carried out in 1/3 octave bands. This allows for the sound produced by insects (ie at high frequencies) to be filtered out. The LA90 noise levels presented are with insect noise removed. In some cases, the background noise level with insect noise removed was below the noise floor of the instrument and an accurate background noise level cannot be provided. However, in accordance with the DERM Ecoaccess Guideline *Planning for Noise Control* (2004), where the measured background noise level is less than 25 dBA, a minimum background noise level of 25 dBA has been adopted.

10.3 Sensitive receptors

Studies of cadastral data and aerial photographs complemented by site visits have been performed to identify receptors (sensitive and commercial) adjacent to the Mainland GTP RoW (sensitive and commercial).

All identified sensitive and commercial receptors within 4 km of the Mainland GTP RoW are presented in Appendix H2 and shown graphically in Appendix H1. Identified industrial receptors (only relevant at vibration sensitive places) are presented in Appendix H3.

Buried infrastructure in the vicinity of the GTP alignment will be sensitive to vibration only. The following infrastructure may potentially be impacted by construction of the Mainland GTP:

- Queensland Gas Pipeline (QGP)
- Jemena gas pipeline
- Ergon services
- Gladstone Regional Council water facilities
- Envestra gas pipeline
- Gladstone Area Water Board water pipeline
- Telstra services
- Vision Stream fibre optic cable

A detailed assessment of the potential impacts to this infrastructure will be required by the contractor when the design is finalised and the RoW is surveyed.

10.4 Modelling methodology

10.4.1 SoundPLAN

In order to calculate the noise emission levels being generated by plant and equipment during construction and operation of the Mainland GTP, SoundPLAN (Version 7.0) environmental computer modelling has been employed. SoundPLAN is a software package which enables compilation of a sophisticated computer model comprising of a digitised ground map (containing ground contours), the location and acoustic sound power levels of potentially critical noise sources on site and the location of receptors for assessment purposes.

The computer model can generate noise emission levels taking into account such factors as the source sound power levels and locations, distance attenuation, ground absorption, air absorption and shielding attenuation, as well as meteorological conditions, including wind effects.

Due to the large spatial coverage of the Mainland GTP RoW, predictions have been carried out for various construction scenarios to determine noise emission levels as a function of distance from construction activities. The function relating noise emission levels to distance for each construction scenario have been used to predict noise emission levels at all identified sensitive receptors. Noise predictions for activities associated with the Mainland GTP RoW are based on the assumption that there is flat, soft ground between the noise source and the receiver and neutral weather conditions (see Table 10.4).

10.4.2 CONCAWE

All noise predictions for this project have been carried out utilising the CONCAWE prediction methodology within SoundPLAN, with the exception of road traffic noise predictions (which have been carried out using the Calculation of Road Traffic Noise (CoRTN) 1988 prediction technique).

The statistical accuracy of environmental noise predictions using CONCAWE was investigated by Marsh (Applied Acoustics 15 - 1982). Marsh concluded that CONCAWE was accurate to ± 2 dBA in any one octave band between 63 Hz and 4 kHz and ± 1 dBA overall.

Construction noise levels have been predicted for neutral weather conditions with the meteorological parameters in Table 10.4.

Table 10.4 Neutral weather conditions

Parameter	Value
Temperature	25°C
Humidity	70%
Pasquill Stability Category	D
Wind Speed	0 m/s

10.4.3 CoRTN

The Calculation of Road Traffic Noise (CoRTN) 1988 prediction technique was utilised to calculate the road traffic noise levels from the GLNG GTP project (and the change in road traffic noise levels due to project related traffic).

These calculations account for traffic volumes, composition, vehicle speed and road surface. CoRTN is the recommended road traffic noise prediction technique in the Department of Transport and Main Roads (DTMR) Code of Practice (2007).

The assessment methodology for determining transportation noise emission contributable to the construction of the Mainland GTP has been carried out by calculating how traffic changes would alter the $LA_{10(18\text{hour})}$ noise level from roadways. This calculation has been undertaken using the CoRTN prediction algorithms.

The $LA_{10(18\text{hour})}$ parameter is the average of the hourly LA_{10} traffic noise level between the hours of 6 am and midnight.

To calculate the incremental change in traffic noise levels due to Mainland GTP RoW related traffic, Equation 1 (shown below) from Section 42.2 of the CoRTN manual was used.

$$\Delta L_f = 10 \text{Log}_{10} \left(\frac{Q'}{Q} \right) + 33 \text{Log}_{10} \left(\frac{v' + 40 + \frac{500}{v'}}{v + 40 + \frac{500}{v}} \right) + 10 \text{Log}_{10} \left(\frac{1 + \frac{5p'}{v'}}{1 + \frac{5p}{v}} \right)$$

(Equation 1)

Where, ΔL_f = change in noise level
 Q = existing traffic volume Q' = future traffic volume
 V = existing traffic speed V' = future traffic speed
 p = existing % heavy vehicles p' = future % heavy vehicles

10.5 Assessment methodology and modelling assumptions

The Mainland GTP will be constructed by a cut and cover construction technique, with blasting only required to excavate the trench in areas of rock which is not excavated by mechanical methods (such as an excavator with rock hammer). The Mainland GTP RoW noise and vibration emissions have been assessed for the following construction activities:

- Ship unloading at Gladstone Port and Port Alma
- Road transportation of pipe joints and workforce movements
- General construction of GTP
- Blasting
- Construction and operation of construction camps

10.5.1 Ship unloading at Gladstone Port

Two ships containing 6,700 pipe joints, required to construct the 80 km of pipeline nearest to the LNG facility on Curtis Island, will be unloaded at Gladstone Port.

Noise from ships docking and unloading at the port is already part of the existing noise environment at this location. The ship unloading and re-loading associated with the Mainland GTP will not change or deviate from those activities currently being carried out in the port area.

10.5.2 Ship unloading at Port Alma

Eleven (11) ships containing 28,300 pipe joints for the Mainland GTP will dock and unload at Port Alma over a 10 month period.

There is only one identified sensitive receiver affected by the ship unloading at Port Alma and truck movements between Port Alma and the pipeline joints laydown area at Lots 5, 6 and 96 (20 km west of the Port). The receiver near the Port and the pipe laydown area at Lots 5, 6, and 96 are shown in Figure 10.1. It should be noted that the sensitive receiver is located in an area where the land use is predominantly industrial.



Figure 10.1 Sensitive receptor at Port Alma

The Port access road and ship unloading dock are at distances of approximately 50 m and 500 m from the nearest facade of the sensitive receiver respectively.

Unloading

The dominant noise source for the unloading of the ship has been assumed to be the ships own auxiliary power which is required to power the onboard crane. The typical noise level expected from the ships auxiliary power and crane is presented in Table 10.5.

Table 10.5 Sound power level ship unloading

Activity	A-weighted sound power level LA10 in octave bands centre frequency (Hz)								Overall dBA
	63	125	250	500	1k	2k	4k	8k	
Ship unloading	86	94	97	98	97	92	83	71	103

Traffic

Over a ten month period, approximately 11 ships will off-load a total of 28,300 pipe joints through Port Alma. Pipe joints will be transferred using semi trailers from the existing wharf off-loading facilities at Port Alma to the temporary pipe lay down area at Lots 5, 6 and 96 20 km west of the Port. It is expected to take four days working 24 hours per day to unload each ship. This results in a project related peak daily traffic volume of approximately 214 heavy vehicle movements on the Bajool Port Alma Road, as summarised in Table 10.6. The speed limit on the Bajool Port Alma Rd adjacent to the sensitive receiver location is 40 km/hr.

Table 10.6 Transportation of pipe joints during unloading of ships at Port Alma

Route	Affected roads	Peak daily project traffic volumes ¹	Vehicle type	Existing traffic volumes ² (AADT) ³ / % heavy vehicles
Port Alma to Lots 5, 6 and 96	Bajool Port Alma Rd	428 per 24 hr (18 per 1 hr) during 4 day unloading	Semi trailer	268 / 39%

Note 1: Traffic for both directions, ie includes empty returning vehicles.

Note 2: Existing traffic volumes and % heavy vehicle data sourced from DTMR.

Note 3: Existing traffic volumes are Annual Average Daily Traffic (AADT), defined as the number of vehicles passing a point on the section of road in a 24 hour period averaged over a whole year. The AADT numbers above are for vehicles travelling in both directions.

The traffic volumes (existing and project related) are well below those required to accurately predict noise levels using CoRTN. Noise impacts from heavy vehicle movements have therefore been assessed by predicting maximum pass-by noise levels at the identified sensitive receiver.

The sound power level for a semi trailer (medium trucks) travelling at approximately 30 km/hr is 101 dBA. This was sourced from the US Department of Transport TNM (1998). The noise emission level was used to predict the noise level at the identified sensitive receiver approximately 50 m from the Bajool Port Alma Rd, see Figure 10.1.

10.5.3 Mainland GTP RoW project related traffic

The Mainland GTP RoW construction works will extend from the area around Roma, Injune and Rolleston in the west to Gladstone in the east. The road network providing access to the Mainland GTP RoW are a combination of sealed state controlled roads and un-sealed (gravel) local government roads. The state controlled road network predominantly has a large volume of traffic travelling at high speeds ranging from 80 to 110 km/hr, whereas the gravel roads providing access to the Mainland GTP RoW have lower traffic volumes and speeds. The road network proposed to be used for traffic associated with the Mainland GTP RoW is shown in Figure 10.2.

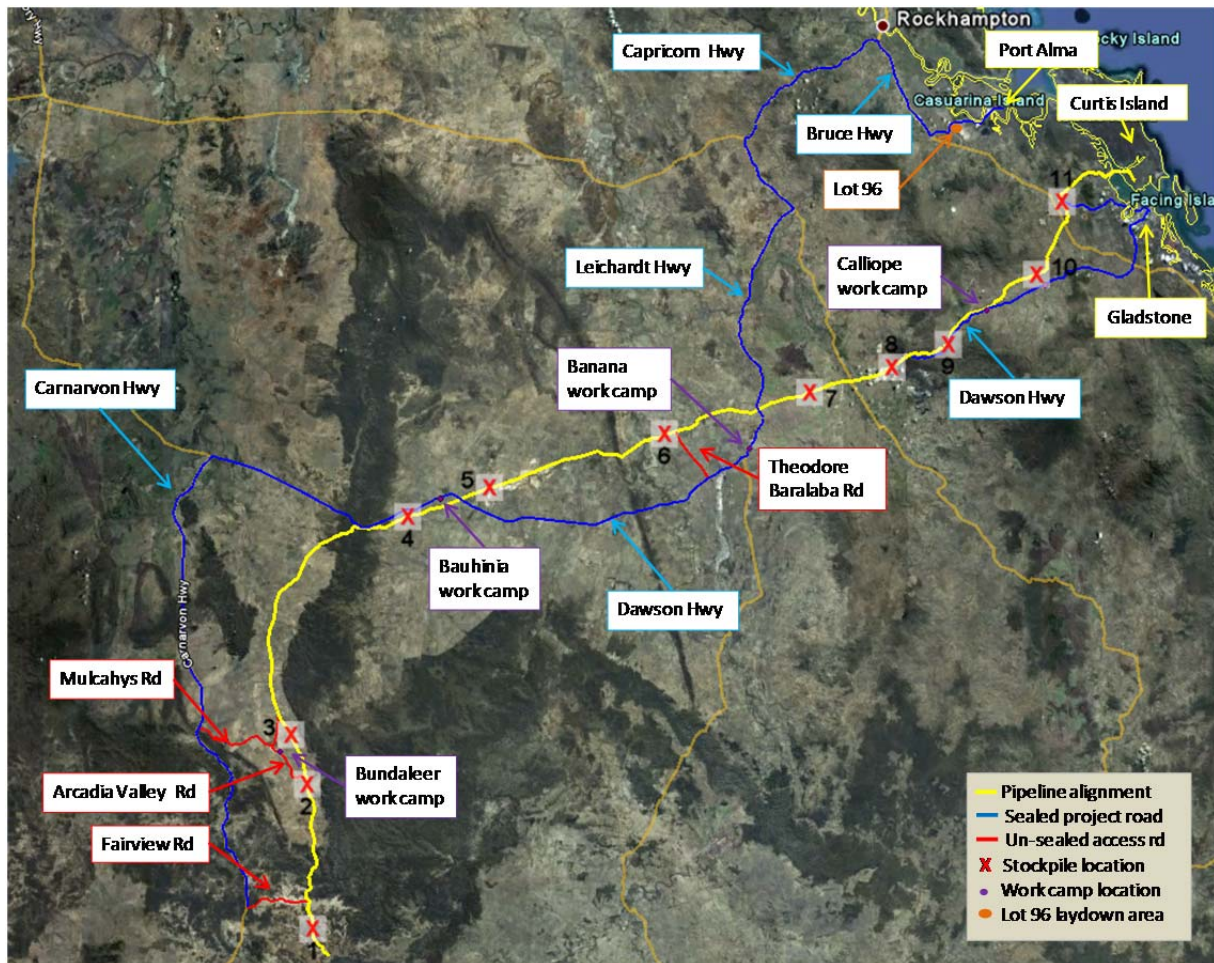


Figure 10.2 Road Network Providing Access to GTP Alignment

Transportation of pipe joints

From the temporary lay down area at Lots 5, 6 and 96 the pipe joints will be transported via road to the other designated lay down areas along the Mainland GTP RoW (stockpiles 1-9 as illustrated in Figure 10.2). It has been assumed to take approximately one month (each truck carting for 23 days) to transport the pipe joints required for each stockpile.

The Port of Gladstone will be used to unload pipe joints required for 80 km of pipeline alignment. These pipe joints will be transported by road using the Dawson Hwy (to Stockpile 10) and Gladstone – Mt. Larcom Rd (to Stockpile 11).

Information from the ‘GLNG PROJECT Road-use Management Plan’ and SAIPEM, ‘GLADSTONE LNG PIPELINE Engineer, Procurement and Construction (EPC)’ documents was used to predict the maximum volume of traffic associated with the GLNG GTP. Existing traffic volumes and percentage heavy vehicle data for the State controlled roads was sourced from DTMR. A range is given for most of the existing traffic because the long sections of road have varying traffic flows.

Table 10.7 and Table 10.8 below show predicted peak traffic volumes associated with the transportation of pipeline joints and existing traffic volumes for both the state controlled roads and local government roads respectively.

Table 10.7 Project related traffic volumes – transport of pipe joints on state controlled roads

Route	Affected roads	Peak daily project traffic volumes ¹	Vehicle type	Existing traffic volumes ² (AADT) ³ / % heavy vehicles
Gladstone Port to Stockpile No. 11	Gladstone Port Access Rd	50	Semi Trailer	1,770 / 30%
	Hanson Rd,	50	Semi Trailer	7,069-8,132 / 14-18%
	Gladstone Mt Larcom Rd	50	Semi Trailer	2,934-8,931 / 13-20%
Gladstone Port to Stockpile No 10	Gladstone Port Access Rd	50	Semi Trailer	1,770 / 30%
	Dawson Hwy	50	Semi Trailer	1,024-2,8614 / 3-25%
Lots 5, 6 and 96 to Pipeline Stockpiles 1 - 9	Bajool Port Alma Rd	104	Semi Trailer	268 / 39%
	Bruce Hwy	104	Semi Trailer	5,201-5,429 / 23-27%
	Capricorn Hwy	52	Type 1 Road Train	3,455-15,741 / 11-22%
	Leichhardt Hwy	52	Type 1 Road Train	645-872 / 24-27%
	Dawson Hwy,	52	Type 1 Road Train	207-1,660 / 14-30%
	Carnarvon Hwy	52	Type 1 Road Train	336-406 / 32-36%

Note 1: Traffic for both directions, ie includes empty returning vehicles.

Note 2: Existing traffic volumes and % heavy vehicle data sourced from DTMR.

Note 3: Existing traffic volumes are Annual Average Daily Traffic (AADT), defined as the number of vehicles passing a point on the section of road in a 24 hour period averaged over a whole year. The AADT numbers above are for vehicles travelling in both directions.

Table 10.8 Project related traffic volumes – transport of pipe joints on un-sealed (gravel) public roads

Route	Affected roads	Peak daily project traffic volumes ¹	Vehicle type	Existing traffic volumes ² (AADT) ³ and % heavy vehicles
Access Road to Stockpile 6	Theodore Baralaba Rd	44	Type 1 Road Train	No data available
Access Road to Stockpile 3	Mulcahys Road	48	Type 1 Road Train	17 / Unknown
Access Road to Stockpile 2	Mulcahys Rd, Arcadia Valley Rd	28 28	Type 1 Road Train	17 / Unknown 21 / Unknown
Access Road to Stockpile 1	Fairview Rd	30	Type 1 Road Train	No data available

Note 1: Traffic for both directions, ie includes empty returning vehicles.

Note 2: Existing traffic volumes and % heavy vehicle data sourced from DTMR.

Note 3: Existing traffic volumes are Annual Average Daily Traffic (AADT), defined as the number of vehicles passing a point on the section of road in a 24 hour period averaged over a whole year. The AADT numbers above are for vehicles travelling in both directions.

The traffic volumes (existing and project related) on the un-sealed public roads are well below those required to accurately predict noise levels using CoRTN. Noise impacts from heavy vehicle movements have therefore been assessed by predicting maximum pass-by noise levels at all identified sensitive receivers adjacent to these roads.

The sound power level for a road train travelling at approximately 70 km/hr is 109 dBA. This was sourced from the SLR Consulting Noise Source Database. This noise emission level was used to predict the noise level at all identified sensitive receivers adjacent to the roads specified in Table 10.8.

Transportation of equipment from Brisbane

185 semi trailers loaded with equipment will be transported from Brisbane via the Warrego Hwy to the start of the Mainland GTP RoW during the first two weeks at the start-up of the project. Due to the existing high traffic volumes along the Warrego Hwy (typically greater than 15,000 vehicles per day) and predicted low numbers of project related traffic (approximately 20 semi-trailers per day over the two week period), any change in traffic noise levels due to the Project will be negligible.

Transportation of workforce personnel

Personnel traffic will travel along the sealed State controlled roads with the exception of the Bundaleer and Banana work camps for which vehicles will travel along Arcadia Valley Road and Theodore Baralaba Road respectively. It is anticipated that there will be 37 buses / minibuses and 88 4WD's transporting personnel to and from the construction camps each day.

Transportation along the Mainland GTP RoW

250 light vehicles and 250 heavy vehicles per day will travel on the access road along the Mainland GTP RoW. These vehicle movements have been included and assessed as part of the construction scenarios modelled for the Mainland GTP section.

10.5.4 Construction of the Mainland GTP RoW

The construction plant and equipment modelled for the purposes of the noise assessment are included in Table 10.9. The construction scenarios for which noise modelling has been undertaken are presented in Table 10.10.

Predicted construction noise levels will inevitably depend upon the number of plant items and equipment operating at any one time and on their precise location relative to the receiver(s). Therefore a receiver will experience a range of noise levels representing "minimum" and "maximum" construction noise emissions depending upon:

- The location of the particular construction activity (ie if the plant item of interest were as close as possible to, or further away from the receiver of interest)
- The likelihood of the various items of equipment operating simultaneously

Due to the large spatial area which the Mainland GTP RoW will cover, the noise assessment methodology has been based on predicting noise levels at various offset distances from the RoW, assuming propagation over flat, soft ground. The distance from the construction of the Mainland GTP RoW to each of the identified receptors along the RoW has been used to calculate the noise level at each receiver. The predicted construction noise levels are correct for neutral meteorological conditions (see Table 10.4).

Construction plant and equipment noise sources

The sound power levels of plant items that would be used for the GTP construction are LA10 noise emission levels and are shown in Table 10.9. The sound power levels for the proposed construction plant items were obtained from the SLR Consulting Noise Source Database, US Department of Transport TNM (1998), BSI British Standards BS 5228-1:2009 and Engineering Noise Control by Bies, D.A., and Colin, H.H., (2003).

Table 10.9 Mainland GTP RoW construction plant and equipment – sound power levels

Ref no.	Plant item	A-weighted sound power level LA10* in octave bands centre frequency (Hz)									Overall dBA
		31.5	63	125	250	500	1k	2k	4k	8k	
1	Motorgrader		85	94	97	99	107	102	98	87	110
2	Dozer	69	86	95	99	107	103	102	100	92	110
3	Excavator	65	86	94	95	96	98	96	91	83	103
4	Front end loader (FEL)	66	91	96	101	104	102	104	95	86	109
5	Vibrating roller	55	73	88	98	99	100	98	92	84	105
6	Motorsaw	42	65	87	97	103	108	106	109	107	114
7	Water tankers	70	77	89	93	99	103	102	97	88	107
8	4WD	-	-	-	-	94	-	-	-	-	94
9	Minibus 10 seats	-	-	-	-	102	-	-	-	-	102
10	Backhoe	65	86	94	95	96	98	96	91	83	103
11	Backhoe with hammer	67	88	92	100	107	108	110	113	109	117
12	Rock drill equipment	66	88	94	96	103	105	106	104	97	111
13	Explosive truck	61	80	91	93	101	101	106	96	85	109
14	Compressor	59	67	77	83	92	98	99	97	92	104
15	Dump truck	70	77	89	93	99	103	102	97	88	107
16	Sideboom cat	69	86	95	99	107	103	102	100	92	110
17	Bending machine	67	79	96	100	100	97	97	92	86	106
18	Road tractor		76	78	92	95	101	94	85	77	103
19	Semitrailer flat bed 20/30 tons	73	94	96	103	105	105	104	99	90	111
20	Truck	61	80	91	93	101	101	106	96	85	109
21	Greasing truck	70	77	89	93	99	103	102	97	88	107
22	Bus 22 Seats	-	-	-	-	102	-	-	-	-	102
23	Pipe facing machine	-	74	91	96	95	92	92	87	81	101
24	Crawler tow tractor	-	71	90	92	94	97	94	91	84	102
25	Diesel welding machine	63	76	81	85	96	96	102	93	84	104
26	Generator kW 200	67	78	95	99	99	96	96	91	85	105
28	Bus 50 seats	-	-	-	-	102	-	-	-	-	102
29	Mob screen Vulcano –180 m3/h	-	81	89	93	99	97	98	95	86	104

Note - denotes not available

* Very steady state noise for some operational conditions will be limited by the $L_{A90,T}$, intermittent construction noise is limited by the $L_{A10,T}$ and some transient events may be limited by the $L_{A1,T}$. For this reason the construction noise has been assessed according to the $L_{A10,T}$ parameter

For the construction noise modelling of the Mainland GTP RoW it has been assumed that there will be up to 700 vehicle movements per day on the RoW access roads. Of these 700 vehicle movements, 200 are considered to be from mobile plant items associated with construction activities being undertaken within the RoW. The remaining 500 vehicle movements are assumed to consist of 250 light and 250 heavy vehicle movements travelling on the access road created within the RoW. The 4WDs and minibuses are considered to be light vehicles, whilst the buses, semi trailers, greasing truck and explosive truck are considered to be heavy vehicles.

The light vehicle movement on the access road within the RoW was modelled as a line source in SoundPLAN with a modelled traffic speed of 40 km/h. Based on a vehicle speed of 40 km/h, the calibrated vehicle pass-by distance of 15 m, and the sound power level for 250 light vehicles (4WDs) over a 12 hour period, the sound power level per meter of road was calculated to be 61 dBA/m.

The heavy vehicle movement on the access road was modelled as a line source in SoundPLAN with a modelled traffic speed of 30 km/h. Based on the vehicle speed of 30 km/h, the calibrated vehicle pass-by distance of 15 m, and the sound power level for 250 heavy vehicles (buses) over a 12 hour period, the sound power level per meter of road was calculated to be 70 dBA/m.

Construction scenarios and typical plant items

Construction of the Mainland GTP would be carried out in accordance with the requirements of *AS 2885 Pipelines – Gas and Liquid Petroleum* and the Australian Pipeline Industry Association *Code of the Environmental Practice (2009)*. Table 10.10 summarises the modelled construction scenarios and plant and equipment items.

Table 10.10 Mainland GTP RoW construction scenarios and typical plant items

Stage	Scenario	Description	Typical plant items	No
1	RoW and bush clearing	Graders, front end loaders and dozers are utilised for clearing and grading of the RoW. Trees, timbers and vegetation are stockpiled on the edge of the easement in preparation for re-spreading during rehabilitation	Motorgrader	2
			Dozer	4
			Excavator	2
			Front end loader (FEL)	2
			Vibrating roller	1
			Motorsaw	6
			Water tankers	1
			4WD	1
			Minibus 10 seats	2
2A	Rock exposure	Large exposed rocks are broken into small materials using dozers, backhoes and backhoes with hammers	Dozer	1
			Backhoe	1
			Backhoe with hammer	2
			4WD	3
			Minibus 10 seats	1
2B	Pre-blasting preparation	In areas of large amount of rocks, drilling and blasting may be required	Rock drill equipment	4
			Explosive truck	1
			Compressor	1

Stage	Scenario	Description	Typical plant items	No
3	Stringing and bending	Steel pipe is laid adjacent to the pipeline trench. If required, pipe sections are bent to match changes in the alignment of the pipeline	Sideboom cat	4
			Bending machine	2
			Road tractor	11
			Semitrailer flat bed 20/30 tons	11
			Truck	2
			4WD	1
			Minibus 10 seats	4
4	Trenching	Trenches for the pipeline are dug	Backhoe	18
			Backhoe with hammer	2
			Greasing truck	1
			Bus 22 seats	1
			4WD	2
5	Welding and sand blasting	Pipe sections are welded together	Sideboom cat	6
			Pipe facing machine	5
			Crawler tow tractor	2
			Diesel welding machine	2
			Generator kW 200	4
			Truck	2
			Bus 50 seats	2
4WD	1			
6	Lowering & backfilling	Pipe string is lowered into the trench and the trench is backfilled with earth	Dozer	6
			FEL (wheel loader)	7
			Backhoe	8
			Mob. screen. Vulcano – 180 m ³ /h	4
			Sideboom cat	5
			Greasing truck	1
			Dump truck	10
			Bus 22 seats	2
			Minibus 10 seats	1
			4WD	2
7	Clean-up and restoration	This phase may include contouring and revegetation of the work area	Dozer	2
			Motorgrader	1
			Backhoe	2
			Dump truck	4
			4WD	1

It has been assumed that traffic movements on the access road within the RoW are not limited to only one construction stage (ie the vehicle movements on the access road may transport personnel or equipment between the various construction stages).

It is assumed that all semi trailers (flat bed 20/30 tonnes), required for the stringing and bending scenario, will travel on the access road, as do five of the ten dump trucks required for the lowering and backfilling scenario.

Pipeline Construction at Bauhinia

Detailed 3D noise modelling was performed for the pipeline construction scenario “lowering and backfilling” adjacent to Bauhinia.

The location of the access road and the construction plant items along the proposed Mainland GTP RoW adjacent to Bauhinia are shown in the 3D noise contour map in Appendix H4.

The 3D SoundPLAN noise model was used to predict the Mainland GTP RoW construction noise emissions at the surrounding sensitive receivers (particularly those in Bauhinia). The construction noise emission levels were also predicted at the position of the construction camp in Bauhinia. The locations of the sensitive receivers where the noise levels were assessed are shown on the 3D noise contour map in Appendix H4.

10.5.5 Construction vibration

The following section addresses the vibration impacts associated with the construction of the Mainland GTP RoW. The dominant sources of vibration emission from the construction of the Mainland GTP RoW are:

- Rockbreaking
- Compaction with vibratory rollers
- Heavy vehicle movements

Heavy trucks passing over normal (smooth) road surfaces generate relatively low vibration levels, typically ranging from 0.01 mm/s to 0.2 mm/s at the footings of buildings located 10 m to 20 m from a roadway. Very large surface irregularities can cause levels up to 5 to 10 times higher. Based on a fairly rough gravel access road, vibration levels of up to 1 mm/s at 10 m from the access road have been assumed.

The typical maximum levels of ground vibration from rockbreaking, vibratory rollers and heavy vehicle movements sourced from SLR Vibration Measurement Data Base are shown in Figure 10.3.

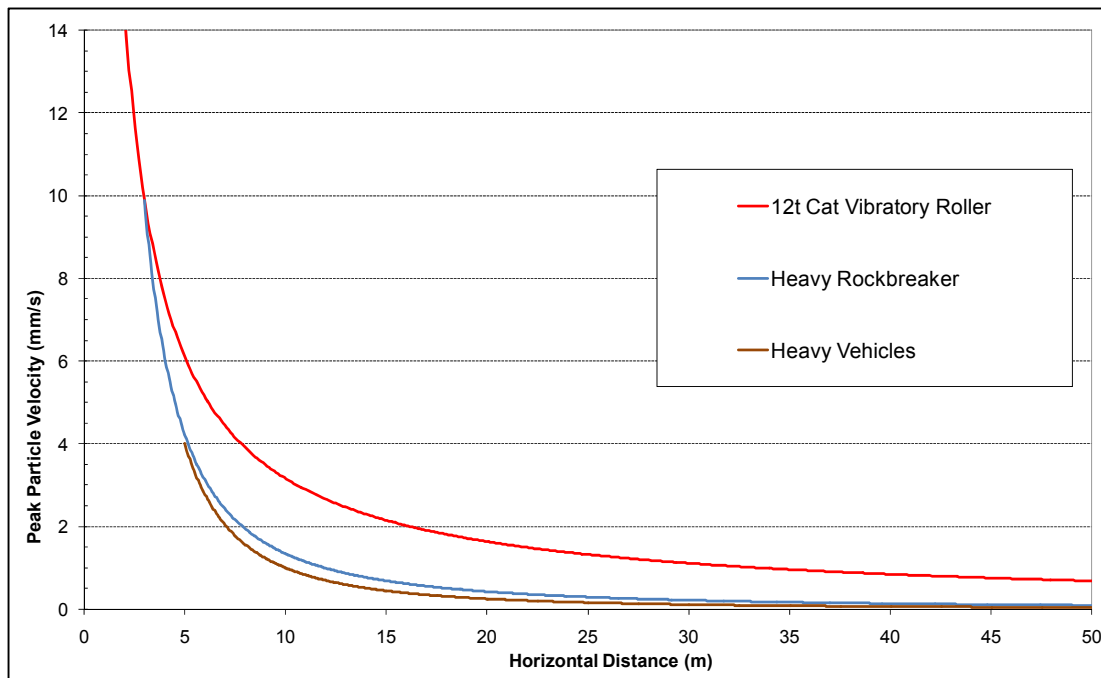


Figure 10.3 Maximum ground vibration – rockbreaking, vibratory rollers and heavy vehicles

10.5.6 Blasting

Blasting may be required to form the trench in areas of rock which is not excavated by mechanical methods (such as an excavator with rock hammer).

Details of the blast parameters and design required for the Mainland GTP RoW are not available at this stage, however it is assumed drill and blast techniques incorporating confined blasting (ie blasting of hole/trench on open ground) will be employed. It is assumed that no more than approximately 20 kg of Maximum Instantaneous Charge (MIC) will be required. The Australian Standard AS 2187.2 (2006) and the ICI Explosives Blasting Guide (1995) gives prediction formulas for predicting the ground vibration and airblast overpressure from blasting as follows:

Ground vibration

$$V = 5000 \left(\frac{\sqrt{Q}}{R} \right)^{1.6} \quad \text{(Equation 2)}$$

Where, V = Ground vibration, mm/s
 Q = Maximum Instantaneous Charge (MIC), kg
 R = Distance from blast, m

Airblast overpressure

$$P = 185 \times 10^3 \left(\frac{Q^{1/3}}{R} \right)^{1.2} \quad \text{(Equation 3)}$$

Where, P = Airblast overpressure, Pa
 Q = Maximum Instantaneous Charge (MIC), kg
 R = Distance from blast, m

The airblast overpressure can be significantly reduced if fully confined blast hole charges are employed (ie by using signal tube surface initiation, adequately covering all exposed detonating cord and by increasing the stemming and/or burden distance).

Detailed blast predictions should be carried out for locations where blasting is required for the Mainland GTP RoW when the blast design and parameters have been confirmed.

10.5.7 Construction camps

Construction camps to accommodate for approximately 450 construction workers will be set up during the construction of the GTP. The construction camps will be temporary and will be dismantled after completion of the works. The different camp locations will be progressively occupied when the works progress to a point that results in the minimum transportation distance for the workforce to the construction sites. The proposed locations of the construction camps are shown in Figure 10.4 and distances to the nearest receivers identified in Table 10.11.

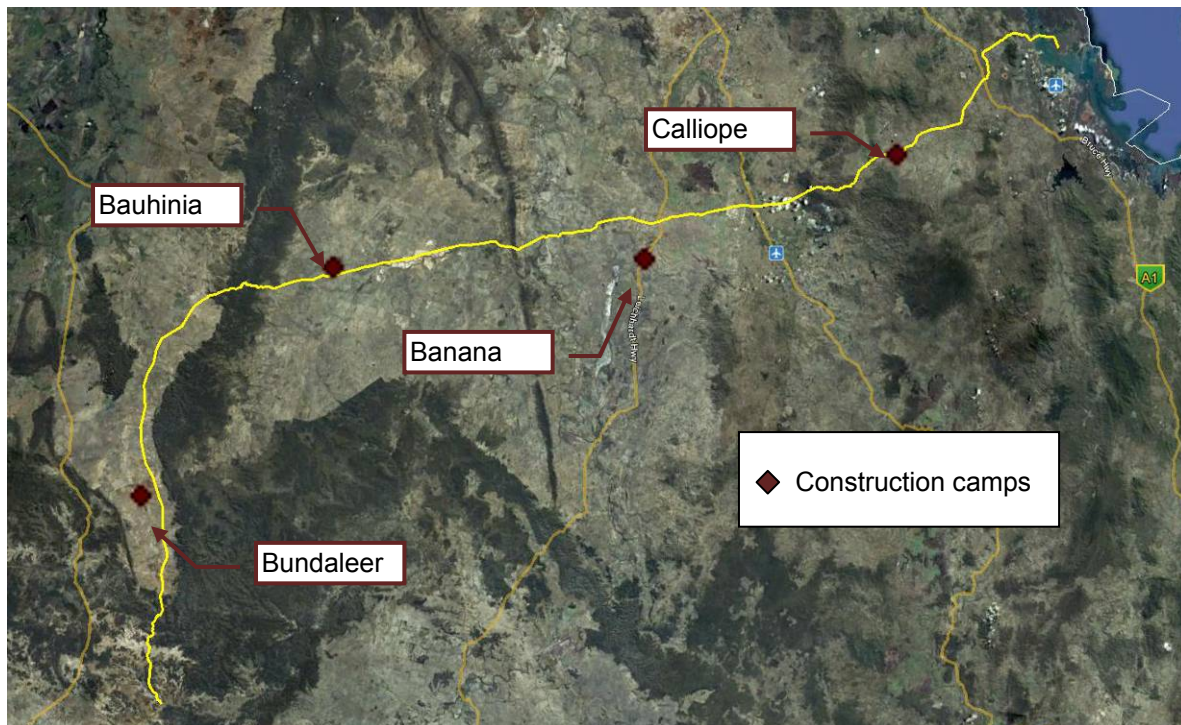


Figure 10.4 Locations of construction camps

Table 10.11 Distances between construction camps and the nearest sensitive receivers

Construction camp locations	Distance to nearest sensitive receiver (m)
Calliope	1,200 m (the second nearest is 2,200 m)
Bandaleer	1,900 m
Bauhinia	2,100 m
Banana	660 m (760 m to the nearest receiver of the township of Banana)

The predictions of noise emission from construction of the construction camps have been undertaken for neutral meteorological conditions (see Table 10.4).

Construction of construction camp

Construction of the temporary construction camps will involve the construction staging scenarios described in Table 10.12 and the plant items listed in Table 10.13.

The construction staging scenarios and associated plant items and sound power levels have been used to predict the acoustic footprint of the construction camp sites. It is considered that construction of the camp site will be carried out in the day time period only.

Table 10.12 Camp site construction scenarios and typical plant items

Stage	Scenario	Description	Typical plant items	No
1	Clear and grade	Clearing and levelling the site (approximately 240 x 280 m)	Excavator	2
			Dozer	1
			Dump truck	2
2	Gravel surfacing	Distribution of a 100 mm to 150 mm layer of gravel throughout the site	Dump truck	2
			Front end loader	1
			Compactor	1
3	Installation of pre-fabrication units	Truck deliveries of pre-fabricated units installed on stamps by crane	Truck	2
			Crane 20t	1

The sound power levels shown in Table 10.13 are for plant items associated with the construction of the camps. The sound power levels for the proposed camp site construction plant items were obtained from the SLR Consulting Noise Source Database.

Table 10.13 Construction plant and equipment sound power levels (SWL) – construction camps

Ref no.	Plant Item	A-weighted sound power level LA10* in octave bands centre frequency (Hz)									Overall dBA
		31.5	63	125	250	500	1k	2k	4k	8k	
1	Dozer	69	86	95	99	107	103	102	100	92	110
2	Excavator	65	86	94	95	96	98	96	91	83	103
3	Front end loader (FEL)	66	91	96	101	104	102	104	95	86	109
4	Compactor	55	73	88	98	99	100	98	92	84	105
5	Truck	61	80	91	93	101	101	106	96	85	109
6	Dump truck	70	77	89	93	99	103	102	97	88	107
7	Crane 20t		82	91	94	100	100	97	88	78	105

Note * Very steady state noise for some operational conditions will be limited by the $L_{A90,T}$, intermittent construction noise is limited by the $L_{A10,T}$ and some transient events may be limited by the $L_{A1,T}$. For this reason the construction noise has been assessed according to the $L_{A10,T}$ parameter

Predicted construction noise levels will inevitably depend upon the number of plant items operating at any one time and on their precise location relative to the receiver(s). Therefore a receiver will experience a range of values representing “minimum” and “maximum” construction noise emissions depending upon:

- The location of the particular construction activity (ie if the plant item of interest were as close as possible to or further away from the receiver of interest)
- The likelihood of the various items of equipment operating simultaneously

The noise assessment methodology has been based on predicting noise levels at various distances from the construction activities, assuming propagation over flat, soft ground (ie open grassland) to a typical receiver. Noise sources have been modelled at heights of between 1 and 3.5 metres depending on the plant item (ie excavators, dozers etc at 3.5 m and generators, compressors at 1 m).

Construction Camp Operational Noise Emissions

For the modelling of construction camp operational noise emissions it has been assumed that there will be up to 289 small air-conditioning units, 16 larger size air conditioning units, five diesel fired generators, 88 light vehicle parking movements and 37 heavy vehicle parking movements.

The vehicle movement at the construction camp was modelled as a line source in SoundPLAN. The sound power level per meter for 4WDs and busses were calculated based on pass-by noise levels in the US Department of Transport TNM (1998). The total sound power level per meter from 88 light vehicles (4WDs) over a 12 hour period was calculated to be 56 dBA/m and from 37 heavy vehicles (buses) to be 62 dBA/m.

The height of all the camp facility buildings used in the SoundPLAN modelling was assumed to be 4 m.

The sound power levels assumed for the dominant noise sources associated with the construction camps are summarised in Table 10.14. The typical layout of a construction camp and the distribution of assumed noise sources are shown in Appendix H5.

Table 10.14 Construction camp operational plant items sound power levels (SWL)

Ref no.	Plant item	A-weighted sound power level LA10* in octave bands centre frequency (Hz)							Overall dBA
		63	125	250	500	1k	2k	4k	
1	Generators	90	95	95	90	85	80	80	100
2	Larger air-conditioning units	-	-	-	75	-	-	-	75
3	Small air-conditioning units	56	55	55	52	52	49	44	62
4	4WD parking movement	-	-	-	56	-	-	-	56 dBA/m
5	Bus parking movement	-	-	-	62	-	-	-	62 dBA/m

Note - Denotes not available

* Very steady state noise for some operational conditions will be limited by the $L_{A90,T}$, intermittent construction noise is limited by the $L_{A10,T}$ and some transient events may be limited by the $L_{A1,T}$. For this reason the construction noise has been assessed according to the $L_{A10,T}$ parameter

The sound power levels specified in Table 10.14 have been used to predict the acoustic footprint of a typical construction camp for the daytime and night time periods. For the night time period it has been assumed that all five generators and all small air-conditioning units will be operating at the camp. No vehicle movements or use of the larger air-conditioning units have been assumed for the night-time period.

Construction camp operational noise emissions at Bauhinia

Detailed 3D noise modelling was performed to predict noise emissions from the operation of the Bauhinia Construction Camp. The noise sources are as specified in Table 10.14 and their locations are shown in Appendix H5.

10.6 Potential adverse or beneficial impacts from noise and vibration (construction and operation)

The following sections present the results of the noise and vibration modelling for the Mainland GTP RoW. Where applicable, noise and vibration management and mitigation measures are nominated.

10.6.1 Ship unloading at Gladstone Port

Noise from ships docking and unloading at the port is already part of the existing noise environment at this location. The ship unloading and re-loading associated with the Mainland GTP RoW will not change or deviate from those activities currently being carried out in the port area. It should also be noted that there will only be two ships docking at Gladstone Port over a period of up to two months. Therefore, it is considered that the noise environment in the port area will not be adversely affected by ship unloading activities.

10.6.2 Ship unloading at Port Alma

There is only one identified sensitive receiver in the vicinity of ship unloading activities at Port Alma and truck movements between Port Alma and the laydown area at Lots 5, 6 and 96 (see Figure 10.1). As with Gladstone Port, noise from ships docking and unloading at Port Alma is already part of the existing noise environment, as well as intermittent vehicle movements including truck movements associated with the bulk storage facility.

Unloading

The predicted noise emission level from unloading of the ship at the sensitive receiver at Port Alma is 40 dBA LA10.

The ship unloading events occur on a 24 hour a day basis for 4 days per ship. The existing night time background noise level at the sensitive receiver at Port Alma is expected to be below 25 dBA. However, ambient noise levels increase for the duration of normal port activities and intermittent vehicle movements when they occur.

The predicted noise level is below the World Health Organisation's sleep disturbance criteria of 45 dBA LAmax internal noise level during night-time, and port activities associated with the project are not expected to be significantly different quantitatively or qualitatively to normal port operations.

Traffic

The maximum pass-by noise levels for the semi trailers transporting the pipe joints to the pipe laydown area at Lots 5, 6 and 96 are predicted to be 59 dBA LAmax. With closed windows, an external to internal facade noise reduction of 15 dBA or more is able to be achieved. This would result in an internal noise level of 44 dBA LAmax from the semi trailer pass-bys at the receptor.

It should be noted that the ship unloading events only occur for a four day period for each ship. And furthermore, this kind of ship activity and associated truck movement are typical of existing noise sources within an industrial area such as Port Alma.

10.6.3 Project related traffic

Transport of pipe joints

The predicted change in traffic noise levels for the different sections of State controlled roads were determined using Equation 1 (see Section 10.4.3) with the traffic volumes and percentage heavy vehicles shown in Table 10.7 and no change in traffic speeds.

The predicted changes in noise levels due to the Mainland GTP RoW related transportation of pipeline joints on State controlled roads is shown in Table 10.15.

Table 10.15 Predicted change in traffic noise levels – state controlled roads

Route	Affected roads	Peak daily project traffic volumes ¹	Vehicle Type	Resultant change in traffic noise levels (dBA)
Gladstone Port to Stockpile No. 11	Gladstone Port Access Rd	50	Semi Trailer	<1
	Hanson Rd	50	Semi Trailer	<1
	Gladstone Mt Larcom Rd	50	Semi Trailer	<1
Gladstone Port to Stockpile No. 10	Gladstone Port Access Rd	50	Semi Trailer	<1
	Dawson Hwy	50	Semi Trailer	0 – 1
Lots 5, 6 and 96 to Pipeline Stockpiles 1 - 9	Bajool Port Alma Rd	104	Semi Trailer	3
	Bruce Hwy	104	Semi Trailer	<1
	Capricorn Hwy	52	Type 1 Road Train	<1
	Leichhardt Hwy	52	Type 1 Road Train	1
	Dawson Hwy	52	Type 1 Road Train	1 - 2
	Carnarvon Hwy	52	Type 1 Road Train	1

Note 1 Traffic for both directions, ie includes empty returning vehicles

From Table 10.15 it can be seen that the change in noise levels along the State controlled roads due to Mainland GTP RoW related traffic movements is equal to or less than 2 dBA, with the exception of Bajool Port Alma Rd.

For residents adjacent to the Bajool Port Alma Rd, the change in traffic noise levels would be just noticeable.

Traffic volumes along the local government controlled gravel roads required to access the Mainland GTP RoW are well below those required to accurately predict noise levels using CoRTN. To predict noise levels from Mainland GTP RoW related vehicles travelling on these roads, sensitive receivers along each road were identified and the distance between the nearest facade of the building and the nearest carriageway determined. From the SLR Consulting noise source database sound power data for a road train travelling at approximately 70 km/hr was used to predict the noise level for a single pass-by at each of the identified sensitive receivers. Table 10.16 to Table 10.19 present the predicted maximum noise level at the nearest sensitive receivers for a road train travelling along the local gravel roads accessing stockpile's along the Mainland GTP RoW.

Table 10.16 Predicted noise levels adjacent Fairview Rd (used for access to Stockpile 1)

Coordinate system MGA55		Lot	Plan	Address	Distance to road (m)	Predicted maximum pass-by noise level (dBA) ¹
Easting	Northing					
681506	7167073	3	WT216	1611 Fairview Road, Beilba	539	49
680457	7167461	3	WT35	77 Beilba Rd, Beilba	407	53
680352	7167281	2	SP194542	1422 Fairview Rd, Beilba	230	57
680277	7166911	2	SP194542	1422 Fairview Rd, Beilba	86	65

Note 1 Predicted noise levels include a +2.5 dBA facade correction. Road train noise levels last for approximately 10 seconds during each pass-by. Along Fairview Rd there are assumed to be only 30 road train pass-bys per day during no more than a one month period

Table 10.17 Predicted Noise Levels adjacent Mulcahys Rd and (South) Arcadia Valley Rd (used for access to Stockpile 2)

Coordinate system MGA55		Lot	Plan	Address	Distance to road (m)	Predicted maximum pass-by noise level (dBA) ¹
Easting	Northing					
668525	7210758	2	TR45	'Arcadia Station & Warreamba' Mulcahys Rd, Rewan	495	50
668428	7210896	2	TR45	'Arcadia Station & Warreamba' Mulcahys Rd, Rewan	350	53
668273	7210936	2	TR45	'Arcadia Station & Warreamba' Mulcahys Rd, Rewan	308	54
666077	7212719	2	TR45	'Arcadia Station & Warreamba' Mulcahys Rd, Rewan	305	54
683322	7205575	12	CP864585	Arcadia Valley Rd, Arcadia	142	61

Note 1 Predicted noise levels include a +2.5 dBA facade correction. Road train noise levels last for approximately 10 seconds during each pass-by. Along Fairview Rd there are assumed to be only 30 road train pass-bys per day during no more than a one month period

Table 10.18 Predicted Noise Levels adjacent Mulcahys Rd and (North) Arcadia Valley Rd (used for access to Stockpile 3)

Coordinate system MGA55		Lot	Plan	Address	Distance to road (m)	Predicted maximum pass-by noise level (dBA) ¹
Easting	Northing					
668525	7210758	2	TR45	'Arcadia Station & Warreamba' Mulcahys Rd, Rewan	495	50
668428	7210896	2	TR45	'Arcadia Station & Warreamba' Mulcahys Rd, Rewan	350	53
668273	7210936	2	TR45	'Arcadia Station & Warreamba' Mulcahys Rd, Rewan	308	54
666077	7212719	2	TR45	'Arcadia Station & Warreamba' Mulcahys Rd, Rewan	305	54
680569	7211757	7	TR39	5744 'Bottletree' Arcadia Valley Rd, Arcadia	545	49
680577	7215713	5	TR10	6071 Arcadia Valley Rd, Arcadia	325	54
680951	7218889	4	TR7	6399 'Marjundale' Arcadia Valley Rd, Arcadia	130	62

Note 1 Predicted noise levels include a +2.5 dBA facade correction. Road train noise levels last for approximately 10 seconds during each pass-by. Along Fairview Rd there are assumed to be only 30 road train pass-bys per day during no more than a one month period

Table 10.19 Predicted Noise Levels adjacent Theodore – Baralaba Rd (used for access to Stockpile 6)

Coordinate system MGA55		Lot	Plan	Address	Distance to road (m)	Predicted maximum pass-by noise level (dBA) ¹
Easting	Northing					
799335	7292534	2	SP128480	1140 Moura-Baralaba Rd, Moura	183	56
800117	7291375	2	SP128480	1140 Moura-Baralaba Rd, Moura	164	57
803233	7287722	26	FN399	510 Moura-Baralaba Rd, Moura	302	51
803728	7286871	13	FN399	510 Moura-Baralaba Rd, Moura	97	61
804081	7286507	40	FN508	370 Moura-Baralaba Rd, Moura	135	58

Note 1: Predicted noise levels include a +2.5 dBA facade correction. Road train noise levels last for approximately 10 seconds during each pass-by. Along Fairview Rd there are assumed to be only 30 road train pass-bys per day during no more than a one month period.

From Table 10.16 to Table 10.19 it can be seen that the outdoor noise levels during a road train pass-by at the nearest residential properties range from approximately 49 to 65 dBA depending on the distance from the roadway.

It should be noted that the receivers along these gravel roads will experience an increase in traffic volumes compared to the low existing volumes. It should also be noted that there will be a maximum of 48 road train pass-bys per day (limited to daytime hours only). Furthermore, the road train pass-bys will only occur for a maximum of one month, with the exception of Mulcahys Road which will be used by road trains for up to two months to gain access to stockpiles 2 and 3.

Transportation of workforce personnel

The transportation of personnel from the Bundaleer and Banana construction camps along Arcadia Valley Road and Theodore Baralaba Road respectively will result in lower pass-by noise levels than those associated with the road train's required for the transportation of pipe joints.

It should be noted that receivers located along the gravel access roads will experience an increase in traffic volumes compared to the low existing volumes. Vehicle movements along these roads will generally be restricted to daytime hours only. Furthermore, workforce related traffic movements associated with each construction camp are only expected to occur for a relatively short duration of up to 6 months.

Transportation along Mainland GTP RoW

An assessment of noise associated with the transportation of equipment and personnel along the Mainland GTP RoW is covered in the construction noise assessment.

10.6.4 Construction of Mainland GTP RoW

Noise emission levels from the construction of the Mainland GTP RoW have been predicted for the construction scenarios specified in Section 10.5.4. The predicted noise emission level for each construction scenario is presented as a noise contour map in Appendix H6. The separation distance from the construction activity to the 50 dBA, 45 dBA, 40 dBA, 35 dBA and 30 dBA noise contour have been marked in the noise contour maps (see Appendix H6). The separation distances are summarised in Table 10.20.

The calculations have been based on the assumption of sound propagation over flat, soft ground (ie open grassland) to a typical receiver at height of 1.5 m and for neutral meteorological conditions (see Table 10.4).

Table 10.20 Predicted noise levels at corresponding separation distances for various construction scenarios – Mainland GTP RoW

Stage	Scenario	Predicted distance to LA10* noise level (m)				
		50dBA	45dBA	40dBA	35dBA	30dBA
1	RoW and Bush Clearing	360	600	940	1400	1990
2A	Rock Exposure	410	570	800	1110	1550
2B	Pre-Blasting Preparation	350	510	730	1030	1440
3	Stringing and Bending	240	380	630	1040	1590
4	Trenching	340	480	690	1000	1460
5	Welding	400	610	890	1290	1840
6	Lowering and backfilling	290	490	810	1310	2010
7	Clean up and restoration	330	490	740	1070	1550

Note * Very steady state noise for some operational conditions will be limited by the $L_{A90,T}$, intermittent construction noise is limited by the $L_{A10,T}$ and some transient events may be limited by the $L_{A1,T}$. For this reason the construction noise has been assessed according to the $L_{A10,T}$ parameter

The functions relating noise emission levels to distance in Table 10.20 have been applied to predict the noise emission level at each receptor along the entire Mainland GTP RoW and are presented in Appendix H7.

It should be noted that construction will only be carried out during the daytime. With a construction progress speed of 50 km per month (approximately 1.8 km a day) along the Mainland GTP RoW the maximum noise emission (as presented in Appendix H7) from each construction stage will not affect any single location for more than a few days.

Furthermore, all activities and works associated with construction of the Mainland GTP RoW will be undertaken in accordance with the control strategies as outlined in Section 10.8.

Pipeline Construction at Bauhinia

Based on the 3D SoundPLAN noise model established for the Bauhinia area, the specific 3D noise prediction adjacent to Bauhinia for the “lowering and backfilling” construction scenario is presented as a noise contour map in Appendix H4. The “lowering and backfilling” construction scenario was modelled at this location as a worst case, since it was determined to have the greatest offset distance to the 30 dBA noise contour in Table 10.20.

The noise predictions at the nearest sensitive receivers (including the Bauhinia construction camp) are summarised in Table 10.21.

Table 10.21 Predicted noise levels from Mainland GTP construction at Bauhinia

Worst Stage Pipeline Construction	Receptor ID ¹	Predicted noise levels
Lowering and backfilling	26	28
	28	25
	29	28
	30	27
	31	25
	32	26
	33	24
	35	31

Note 1: Receptor ID as presented in Appendix H7.

It can be seen in Table 10.21 that the highest predicted noise level in the vicinity of Bauhinia is 31 dBA LA10.

It should be noted that construction will only be carried out during the daytime. With a construction progress speed of 50 km per month (approximately 1.8 km a day) along the Mainland GTP RoW, the maximum noise emission (as presented in Table 10.21) will not affect any single receiver for more than a few days.

Furthermore, all activities and works associated with construction of the Mainland GTP RoW will be undertaken in accordance with the control strategies as outlined in Section 10.8.

10.6.5 Construction vibration

The dominant vibration sources during the construction of the Mainland GTP RoW are expected to be from rockbreaking, compacting rollers and heavy vehicle movements with source vibration levels as shown in Figure 10.3 in Section 10.5.5.

The predicted vibration level at the nearest sensitive receptor (1344 Baralaba-Banana Rd, 103 m distance from RoW) is 0.3 mm/s peak particle velocity (PPV). There are not expected to be any vibration impacts from construction of the Mainland GTP RoW at any sensitive receptors.

The nearest identified structure is approximately 94 m from the Mainland GTP RoW. The maximum predicted vibration level from construction activities associated with the Mainland GTP RoW at this structure is below 0.4 mm/s PPV. Therefore it is considered that there will be no significant vibration impacts on structures from the construction of the Mainland GTP RoW.

A detailed assessment of potential impacts on any buried infrastructure will be required by the contractor when the design is finalised and the RoW is surveyed. Furthermore, all activities and works associated with construction of the Mainland GTP RoW will be undertaken in accordance with the control strategies as outlined in Section 10.8.

10.6.6 Blasting

Blasting may be required to construct the trench in areas of rock which is not excavated by mechanical methods (such as an excavator with rock hammer).

It is assumed that no more than approximately 20 kg of Maximum Instantaneous Charge (MIC) will be required. The vibration and airblast overpressure prediction equations (Equation 2 and Equation 3 in Section 10.5.6) have been graphically presented in Figure 10.5.

The airblast overpressure can be significantly reduced if fully confined blast hole charges are employed (eg by using signal tube surface initiation, adequately covering all exposed detonating cord and by increasing the stemming and/or burden distance). Airblast overpressure for fully confined blast hole charges is shown in Figure 10.5 as the dashed brown line.

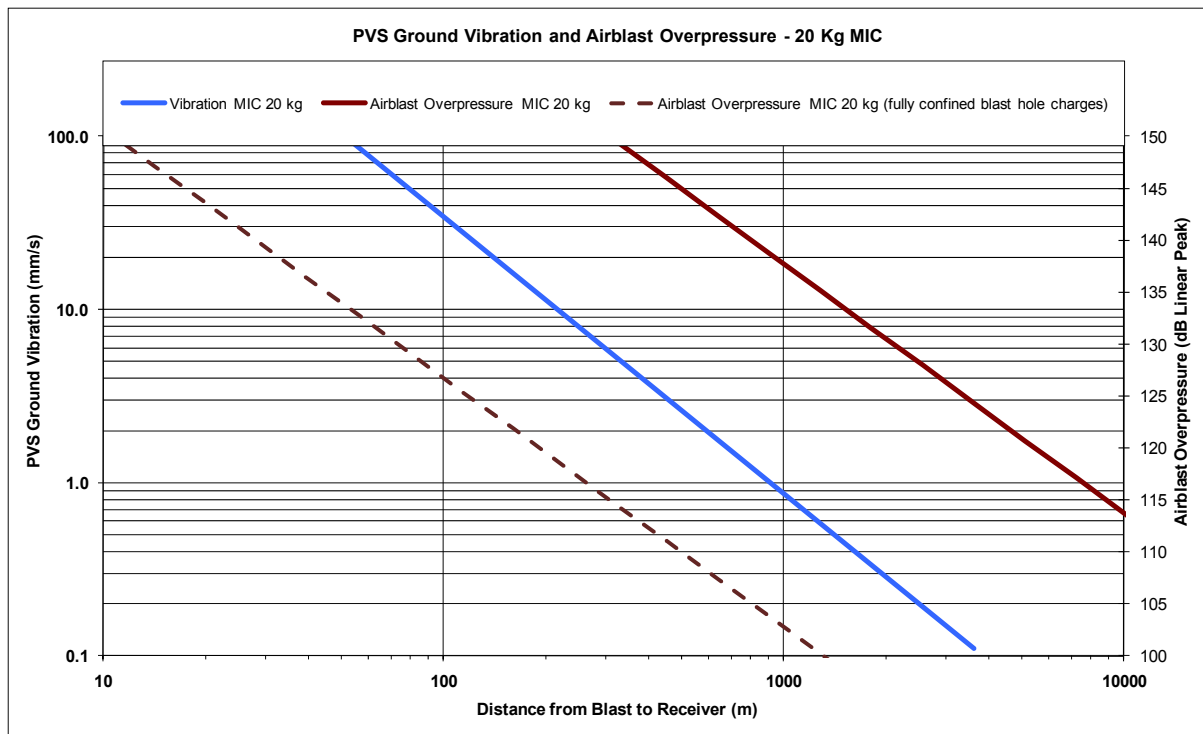


Figure 10.5 Vibration and Airblast Overpressure as a Function of Distance from Blast

Detailed blast predictions should be carried out for locations where blasting is required for the Mainland GTP RoW when the blast design and parameters have been confirmed.

Furthermore, all blasting activities associated with construction of the Mainland GTP RoW will be undertaken in accordance with the control strategies as outlined in Section 10.8.

10.6.7 Construction camps (construction and operation)

To assess the noise impacts associated with construction and operation of the construction camps, generic noise predictions were performed for typical construction scenarios and operational noise sources as specified in Section 10.5.7.

The calculations are based on the assumption of sound propagation over flat, soft ground (ie open grassland) to a typical receiver at height of 1.5m above ground and for neutral weather conditions (see Table 10.4).

Construction of construction camp

The noise prediction for each construction scenario is presented as a noise contour map in Appendix H8. The distance to the 50 dBA, 45 dBA, 40 dBA, 35 dBA and 30 dBA noise contour have been marked in the noise contour maps (see Appendix H8). The distances to noise levels as marked up in the noise contour maps have been summarised in Table 10.22.

Table 10.22 Predicted noise levels at corresponding separation distances for various construction scenarios – construction of construction camp

Stage	Scenario	Predicted distance to LA10* noise level (m)				
		50 dBA	45 dBA	40 dBA	35 dBA	30 dBA
1	Clear and Grade	312	442	616	880	1241
2	Surface Gravelling	302	425	599	841	1184
3	Install of Pre-fabrication Units	280	388	548	768	1068

Note * Very steady state noise for some operational conditions will be limited by the $L_{A90,T}$, intermittent construction noise is limited by the $L_{A10,T}$ and some transient events may be limited by the $L_{A1,T}$. For this reason the construction noise has been assessed according to the $L_{A10,T}$ parameter

The functions relating noise emission levels to distance is used to predict noise emission levels at the nearest receiver to each camp location as shown in Table 10.23.

Table 10.23 Predicted noise levels – construction of construction camps

Construction camp	Distance to nearest receiver (m)	Predicted noise levels		
		Construction stage		
		1	2	3
Calliope	1,200	30	30	28
Bandaleer	1,900	24	23	21
Bauhinia	2,100	22	22	20
Banana	660	39	39	37

As can be seen in Table 10.23, it is only the construction of the Banana construction camp which results in a predicted noise level above 30 dBA. It should also be noted that the construction of the camps is a relatively short duration event and construction activities will only take place during daytime hours.

Furthermore, all construction activities associated with construction of the construction camps for the Mainland GTP RoW will be undertaken in accordance with the control strategies as outlined in Section 10.8.

In regards to impacts of pipeline construction on the construction camps, the proposed camp locations have been assessed as sensitive places (see Appendix H2) for each construction activity in the relevant sections. It should also be noted that numbers of personnel within the camps will be low while pipeline construction activities are occurring as most personnel will be on-site undertaking these construction works.

Operation of construction camp

The noise prediction for the daytime and night-time operation of the construction camp is presented as noise contour maps in Appendix H9. The distance to the 50 dBA, 45 dBA, 40 dBA, 35 dBA and 30 dBA noise contour have been marked in the noise contour maps (see Appendix H9). The distances to noise levels as marked up in the noise contour maps have been summarised in Table 10.24. The noise sources and their locations are as specified in Section 10.5.7.

Table 10.24 Predicted noise levels at corresponding separation distances – operation of construction camp

Scenario	Predicted distance to LA10* noise level (m)					
	50 dBA	45 dBA	40 dBA	35 dBA	30 dBA	25 dBA
Day time ¹	177	271	402	590	861	1255
Night time ¹	177	271	402	590	861	1255

Note 1 The five gas driven generators to supply the construction camp with power is the dominant noise sources. Since all five have been assumed to be operating both day and night the predicted noise levels are the same for daytime and night time

* Very steady state noise for some operational conditions will be limited by the $L_{A90,T}$, intermittent construction noise is limited by the $L_{A10,T}$ and some transient events may be limited by the $L_{A1,T}$. For this reason the construction noise has been assessed according to the $L_{A10,T}$ parameter

The functions relating noise emission levels to distance is used to predict noise emission levels at the nearest receiver to each camp location as shown in Table 10.25.

Table 10.25 Predicted noise levels – operation of the construction camps

Construction camp	Distance to nearest receiver (m)	Predicted noise levels (dBA)	
		Day	Night
Calliope	1,200	26	26
Bandaleer	1,900	20	20
Bauhinia	2,100	19	19
Banana	660	33	33

As can be seen in Table 10.25 the highest predicted operational noise emission level of 33 dBA LA10 is from the Banana construction camp.

Operation of construction camp at Bauhinia

Based on the 3D SoundPLAN noise model established for the Bauhinia area, the specific noise prediction for the operational noise emissions from the Bauhinia construction camp is presented as noise contour maps for the daytime and night time operation in Appendix H10. The noise predictions at the nearest sensitive receivers are summarised in Table 10.26.

Table 10.26 Predicted noise levels – operation of the Bauhinia construction camp

Construction Camp	Receptor ID	Predicted noise levels (dBA)	
		Day	Night
Bauhinia	28	15	15
	29	18	18
	30	13	13
	31	12	12
	32	13	13
	33	11	11

The noise predictions adjacent to the Bauhinia construction camp in Table 10.26 shows that all adjacent sensitive and commercial places have predicted noise levels of less than 20 dBA for both the daytime and night-time operation of the Bauhinia construction camp. There is not expected to be any noise impacts due to the operation of the Bauhinia construction camp.

10.6.8 Operational impacts

Regular inspections will be carried out along the Mainland GTP RoW by vehicle and foot patrols to check on the condition of the GTP and associated infrastructure. Typically maintenance on the Mainland GTP RoW will be carried out by light vehicles and small maintenance crews when required.

Noise impacts from these operational activities are expected to be low and manageable due to the low number of vehicles movements, infrequent maintenance activities and long separation distances from the Mainland GTP RoW to the sensitive receptors.

Furthermore, all activities and works associated with these operational activities will be in accordance with the Operational Management Plan (OMP) which will be developed and implemented prior to the completion of the construction phase.

10.7 Cumulative impacts

The primary potential cumulative impact from noise and vibration is to sensitive receptors during the extended construction phase of the projects. This cumulative impact assessment is based on the impact scope, identification and scoring methodology described in Chapter 2 of this EM Plan. Given the location of the project, cumulative impacts from noise are anticipated to be negligible.

10.7.1 Human receptors (noise and vibration)

Primary background noise levels in the CIC and GSDA are generated from road traffic, railway lines, farming activities and the environment, such as birds, insects and swaying trees.

In general there are few residential receptors close to the RoW in the CIC and GSDA corridors, with the majority of the area zoned as rural. Population density in this area ranges from 0 to 7 people per square kilometre (EIS March 2009). Approximately 20 homesteads are present within or in close vicinity to the CIC and GSDA corridors, particularly between the Calliope River and Callide. These properties are potentially exposed to cumulative noise impacts from the construction phase. Residents around Gladstone and other towns may be exposed to additional traffic noise from the increase in the number and size of trucks and other construction vehicle movements.

Noise from the construction of the GTP will be generated by activities such as clearing and grading of the RoW, blasting, trenching, welding, backfilling, road crossings, and restoration and rehabilitation.

Noise impacts from construction activities will be managed by standard noise control measures as part of each project's EM Plans.

Cumulatively noise impacts could be intensified by overlapping construction activities and /or prolonged by an extended overall construction programme.

Effective noise control measures available for linear infrastructure construction projects are very limited. However, these can be effectively managed for short duration impacts at isolated receptors such as this pipeline construction activity.

There will be negligible permanent cumulative impacts on human receptors (noise and vibration).

10.8 Environmental protection commitments, objectives and control strategies – noise (construction and operation)

The results presented in Section 10.6 indicate that there may be potential for noise impact associated with the construction of the Mainland GTP.

To minimise any noise and vibration impacts the best practice noise and vibration management measures described below in Table 10.27 should be implemented (where practical and feasible).

These noise and vibration mitigation and management measures are consistent with the type of recommendations described in AS 2436-1981 “Guide to Noise Control on Construction, Maintenance and Demolition Sites”.

Table 10.27 Environmental protection commitments, objectives and control strategies – noise

Item	Detail
Environmental Protection Objective	<ul style="list-style-type: none"> To construct the GTP in a manner to minimise the impact of construction related noise and vibrations on surrounding residences and industry
Specific Objectives	<ul style="list-style-type: none"> Compliance with licence conditions and industry standards No warranted complaints from residents and landholders, and warranted complaints responded to within 2 working days Blasting activities will meet the applicable Australian Standards and statutory requirements
Control Strategies	<p>Construction phase</p> <p><i>Construction of Mainland GTP RoW</i></p> <ul style="list-style-type: none"> All activities will be conducted in accordance with licence conditions and industry standards Where heavy rock-breaking and/or drilling and blasting is necessary for rock removal for pipeline trench excavation, the work will be carried out during normal daylight working hours. In general, any blasting that may be required will be carried out in accordance with relevant guidelines and AS 2885 Adequate community consultation will be provided of any atypical noise events and protection of third party infrastructure Where applicable, construction work during evening and night-time periods (6.30 pm to 6.30 am) and on Sundays/Public Holidays will be undertaken in accordance with “best practice” noise management Construction equipment will be fitted with noise control devices Construction equipment will be inspected regularly to maintain optimal working conditions. Throughout construction, the contractor’s environmental representative will undertake regular environmental audits/inspections of the site for compliance will occur on a daily, weekly and monthly basis Audits will be conducted throughout the project to monitor against this EMP and other licence conditions <p><i>Construction blasting</i></p> <ul style="list-style-type: none"> Blasting activities will meet the applicable Australian Standards and statutory requirements All blasting activities will be carried out in a proper manner by a competent person in accordance with best practice environmental management and AS 2187. A blasting plan will be prepared prior to the commencement of any blasting activities, giving consideration of potential airblast overpressure and vibration and will include mitigation measures

Item	Detail
	<ul style="list-style-type: none"> • Monitoring and recording of air blast overpressure and ground borne vibration will be undertaken to investigate any complaint of nuisance, or at the request of GLNG Operations, and the results notified to GLNG Operations within an appropriate timeframe for assessment by the administering authority. Monitoring must include: <ul style="list-style-type: none"> - Maximum instantaneous charge - Location of the blast within the site (including any bench level) - Airblast overpressure level (dB Linear Peak) - Peak particle velocity (mms-1) - Location, date and time of recording - Measurement instrumentation and procedure - Meteorological conditions for blast monitoring (including temperature, relative humidity, temperature gradient, cloud cover, wind speed and direction) - Distance/s from blast site to potentially noise-affected building/s or structure/s <p><i>Managing Complaints</i></p> <ul style="list-style-type: none"> • When the administering authority advises the holder of a complaint alleging nuisance (e.g. caused by dust or noise), the holder must investigate the complaint and advise the administering authority of the action proposed or undertaken in relation to the complaint. • If the administering authority is not satisfied with the proposed or completed action, the holder must undertake monitoring or other action requested by the administering authority • Landholder complaints will be recorded in a complaints register and appropriate corrective actions will be implemented and closed out by the Environmental Manager • Maintain a Complaints Register that includes the following information - identification of the complainant, the identity of the person who is receiving the complaint, the manner in which the complaint was made, the time and date on which the complaint was made, addressed and closed out and description of the complaint. The Register must include identification of the entity responsible for addressing the complaint, a brief summary of any action taken to address the complaint, and a notation as to the satisfaction or dissatisfaction of the complainant with the outcomes <p>Operational phase</p> <p>Typical mitigation and controls for the operational phase of the Project will be detailed in the Operational Management Plan, which will be developed prior to construction</p>
<p>Performance Indicators</p>	<ul style="list-style-type: none"> • No warranted complaints from residents and landholders, and warranted complaints responded to within 2 working days • Compliance with licence conditions and industry standards • Blasting activities will meet the applicable Australian Standards and statutory requirements

11. Social

11.1 Chapter summary

This section provides a summary of the existing social environment and identifies the potential impacts of the Mainland GTP RoW on the surrounding social environment.

11.1.1 Summary of existing social values:

- A Social Impact Assessment (SIA) was undertaken as part of the EIS process to identify the potential impacts of the entire GTP on the surrounding social environment
- The history of the area encompasses maritime and inland exploration; pastoralism and conflict with Indigenous occupants; a long period of gradual 'opening up' of the land, and the development of towns and infrastructure
- GLNG Operations has identified approximately 115 private landholders directly affected by the Mainland GTP RoW
- The majority of the communities in proximity to the Mainland GTP RoW are small (<1,000), with the exception of Duaringa, Biloela and Moura
- As at 30 June 2007, the estimated resident population of Banana Shire Council was 15,420 persons. Central Highlands Regional Council was estimated to be 28,672 persons
- The projected population growth from 2006 to 2026 from the Planning Information and Forecasting Unit (PIFU) is 5.5 % for Banana Shire Council and 52.4 % for Central Highlands Regional Council
- For areas in proximity to the Mainland GTP RoW, the unemployment rate is less than half the State average. Employment rates ranged from 69.7 % to 76.5 %, well above the Queensland average of 61.8 %
- There are a number of heavy industrial projects located towards the eastern end of the GTP in the Gladstone region
- There are five medical and health facilities in the surrounding area of the GTP RoW. Queensland Ambulance Service (QAS) presence along the GTP RoW is covered by the Central Region ambulance service. The Central Region has 37 urban fire stations. Police operate from police stations in Biloela, Moura, Springsure, Theodore, Woorabinda and Duaringa
- There are 11 child care facilities in 5 communities in the Central Queensland Region relevant to the project. There are also 16 places of worship and 7 schools in the vicinity of the GTP RoW area
- Throughout the majority of the GTP RoW, the population is classified as rural, with strong ties to family, the land and the community
- Much of the GTP RoW populations are relatively stagnant or experiencing slight declines

11.1.2 Summary of potential impacts to social values

Construction

The potential community and social impacts are anticipated to primarily occur during the construction period and to a lesser extent during the operational and decommissioning stages. The primary potential impacts will be on the various individual properties located within the GTP RoW. The proposed construction works also have the potential to impact on nearby community values and lifestyle. These impacts are expected to be minor due to the duration of construction, remoteness of the construction site itself and the minor local employment opportunities.

In addition, GLNG Operations are in the process of developing a Social Impact Management Plan (SIMP) that will address local community and landholders concerns.

Operation

The operational workforce is anticipated to be approximately 20 persons. Operational activities will include monthly inspections along the Mainland GTP RoW by vehicle and foot patrols to check on the condition of the GTP and associated infrastructure. Maintenance of the Mainland GTP will be carried out by light vehicles and small maintenance crews on an annual basis, or as and when required. Social and community related impacts from these operational activities are expected to be low and manageable due to the low number of vehicles movements, infrequent maintenance activities and remoteness of the majority of the Mainland GTP RoW.

Furthermore, all activities and works associated with these operational activities will be in accordance with the Operational Management Plan (OMP), which will be developed and implemented prior to the completion of the construction phase.

11.1.3 Summary of proposed mitigation measures for social values

Table 11.1 Mitigation measures for the management of social and community

Item	Detail
Environmental Protection Objective	<ul style="list-style-type: none"> To minimise any social disruption to the local communities from the construction of the Mainland GTP RoW
Specific Objectives	<ul style="list-style-type: none"> No warranted complaints from landholders and the community, and warranted complaints responded to within 2 working days To prevent the occurrence of potential mosquito and biting midge breeding sites and the presence of adult mosquitoes and biting midges
Control Strategies	<ul style="list-style-type: none"> Refer to Table 11.17 for social impacts control strategies to be implemented during pre-construction, construction, operation and decommissioning
Performance Indicators	<ul style="list-style-type: none"> No warranted complaints from landholders and the community, and warranted complaints responded to within 2 working days

11.2 Social Impact Assessment

A Social Impact Assessment (SIA) was undertaken as part of the EIS process to identify the potential impacts of the entire GTP on the surrounding social environment. The SIA involved a desktop review of the existing information on the relevant areas. Data was frequently updated as it became available in order to ensure the most recent information was presented. Preference was placed on the inclusion of local data supplemented with interviews with various agencies and service providers to capture local perceptions as well as quantitative figures.

Data sources for much of the information provided below and also within the SIA were from the local service providers and government agencies. Avenues for information sharing and means for providing the SIA with relevant local information and knowledge were established in the initial site assessments in July 2008. In addition to local information, data from the following sources was used:

- Australian Bureau of Statistics (ABS)
- Department of Local Government and Planning (DLGP) - Planning Information and Forecasting Unit (PIFU)
- Department of Education, Training and the Arts (DETA)
- Queensland Health (QH)
- Other relevant Environmental Impact Statements (EISs)

For the purposes of this chapter, there are three main study area definitions. The Mainland GTP RoW refers to the 40 m/30 m construction corridor; while the Mainland GTP corridor refers to a 5 km wide corridor along the centreline of the GTP and the project area refers to the broader regional area surrounding the Mainland GTP.

11.3 Existing social environment

The area covered by the Mainland GTP RoW includes a diverse landscape stretching from the coastal area of Gladstone, inland to the CSG fields near Roma and Fairview. The history of the area encompasses maritime and inland exploration; pastoralism and conflict with Indigenous occupants; a long period of gradual ‘opening up’ of the land, and the development of towns and infrastructure. Key industries such as cattle and mining have had a profound impact on the history of the region. In the late twentieth century, Gladstone was transformed from a small coastal community dependent on a butter factory and a seasonally operational meatworks, to the site of Queensland’s largest power station and one of the world’s largest alumina plants. The presence of a deep-water port and the development of port facilities helped drive the economic development of Gladstone and the region as a whole. Many towns in the region have also experienced significant recent changes with the advent of large-scale coal mining and gas exploration, mining, mineral production and exportation.

11.3.1 Landholders

The social assessment focuses on the Mainland GTP section of the Project. Information on the specific landholders cannot be included in this report due to the confidentiality agreements GLNG Operations has committed to in discussions with individual landholders. Similar to the negotiations being conducted for the CSG field, GTP negotiations are not assessed in this report. The majority of this chapter examines the impact of the Mainland GTP on the community rather than the directly affected individual landholders.

GLNG Operations has identified approximately 115 private landholders directly affected by the Mainland GTP. Landholders were identified through land deeds and consultation with GLNG Operations Land Agents. Following the identification of potentially affected landholders, formal discussions relating to the proposed activity for the GLNG Operations project were undertaken. GLNG Operations is committed to on-going consultation with potentially affected landholders throughout the process, and has Land Agent officers based at Injune, Moura and Biloela.

11.3.2 Description of the regional community

The Mainland GTP RoW travels through the Bauhinia, Duaringa, Bungil and Banana shires, which are sparsely populated. The eastern end of the GTP RoW is located within the more densely populated Calliope Shire. There are limited built up areas throughout the region, with populations ranging from a few hundred to a few thousand. Listed below are the larger communities and their old shire name, with their new council in parentheses:

- Taroom in Taroom Shire (now Banana Shire Council)
- Biloela and Moura in Banana Shire Council (still Banana Shire Council)
- Duaringa in Duaringa Shire (now Central Highlands Regional Council)
- Rolleston and Springsure in Bauhinia Shire (now Central Highlands Regional Council)
- Emerald in Emerald Shire (now Central Highlands Regional Council)
- Woorabinda in Woorabinda Aboriginal Shire Council
- Calliope Shire (now Gladstone Regional Council)

Additional communities in the general area of the Mainland GTP corridor include Theodore and Banana. Due to the nature of likely impacts from the construction and operation of the GTP and the proximity of the communities to the GTP corridor, most of the social assessment focuses on the overall region, with greater analysis undertaken at the specific areas where deemed necessary. Therefore, the focus for the Mainland GTP is on Banana Shire Council and Central Highlands Regional Council.

11.3.3 Demographic profile

The majority of the communities in the project area are small (<1,000), with the exception of Duaringa, Biloela and Moura (refer Table 11.2). This is a reflection of the rural setting in the study area.

Duaringa Shire is bisected by the proposed GTP; however, the vast majority of the population, including Duaringa, reside significantly north of the route and use the Capricorn Highway as the primary transportation route. As such, potential project effects on the community of Duaringa or the majority of the shire are expected to be low. The proposed GTP route is also located approximately 100 km from Springsure therefore project effects on that community are also predicted to be low.

Table 11.2 Population of key towns within the GTP RoW

Statistical Division	SLA	Town	Town Population (2006)	SLA Population	% of SLA
Fitzroy	Bauhinia (S)	Rolleston	217	2,190	9.9%
		Springsure	829	2,190	37.9%
	Duaringa (S)	Duaringa	6,744	14 523	46.4%
	Banana (S)	Biloela	5,371	13,361	40.2%
		Theodore	444	13,361	3.3%
		Moura	1,774	13,361	13.3%

SLA: Statistical Local Area

Throughout the rest of the Mainland GTP corridor the majority of directly affected people are landholders and their families. Along the entire length of the GTP, there have been discussions with landholders to determine fair compensation, pipe alignment issues and timing to reduce the impact on their property as a result of GTP activities. The communities of Moura and Biloela are likely to experience some activity during the construction phase of the GTP in terms of contractor and staff accommodation, so these communities have been included in the assessment. Due to the nature of this study area and the distribution of people throughout the area (agricultural properties and homesteads), more focus was given to the amalgamated local government data to reflect the broad area in which the Mainland GTP RoW traverses.

As at 30 June 2007, the estimated resident population of Banana Shire Council was 15,420 persons, representing 0.4 per cent of Queensland's population (see Table 11.3). The annual average rate of change in population in Banana Shire Council between 30 June 2002 and 30 June 2007 was -0.4 per cent, compared with 2.4 per cent for the State. Central Highlands Regional Council was 28,672 persons, representing 0.7 per cent of the State's population at the same time. The annual average rate of change in population in Central Highlands Regional Council between 30 June 2002 and 30 June 2007 was 2.3 per cent, compared with 2.4 per cent for the State (OESR, 2008a).

Table 11.3 Estimated resident population by local government area (LGA), Banana Shire Council and Central Highlands Regional Council, 2002, 2006 and 2007 (a)

Local government area	Estimated residential population at 30 June 2007			Change	
	2002	2006	2007	2002 to 2007 (b)	2006 to 2007
	Number			%	%
Banana Shire Council	15,754	15,643	15,420	-0.4	-1.4
Central Highlands Regional Council	25,627	28,256	28,672	2.3	1.5
Queensland	3,714,798	4,090,908	4,181,431	2.4	2.2

Table note (a) Figures may be different from those published in Australian Bureau of Statistics (ABS): *Population Estimates by Age and Sex, Australia and States* (Cat no. 3255.0.55.001). (b) Average annual growth rate. Note: Based on ASGC 2006. Data for Reformed Local Government Area(s) are based on concordant Statistical Local Area data (ASGC 2006). The concordance is population based and has been derived from Planning Information and Forecasting Unit within the Department of Infrastructure and Planning

Source Australian Bureau of Statistics, Regional Population Growth (Cat no. 3218.0) and unpublished data

The projected population growth from 2006 to 2026 from the Planning Information and Forecasting Unit (PIFU) is 5.5% for Banana Shire Council and 52.4% for Central Highlands Regional Council (see Table 11.4). Queensland as a whole is projected to grow by 36.5% over the same period. These figures highlight the differences between the two councils, though the Central Highlands growth rate belies the likely growth around the proposed Mainland GTP RoW. The majority of Central Highlands Regional Council projected population growth is likely to occur in the north of the council, as a result of increased coal activity in the Bowen Basin. This is evident by the current population density in the northern part of the region, as opposed to the southern part around the proposed GTP RoW.

The relative lack of growth in Banana Shire Council is a reflection of the changing demographics in the traditional agricultural areas. Lack of alternate industries has left these areas susceptible to drought and less insulated to economic downturn because of a lack of economic diversification. As a result, growth in Banana Shire Council is more a reflection of the slightly higher natural regeneration rate than migration to the area.

Table 11.4 Banana Shire Council, Central Highlands Regional Shire and Queensland population projections 2006 - 2026

Area	Year				
	2006	2011	2016	2021	2026
Banana Shire Council	15,634 (1.2%)	15,830 (0.2%)	15,987 (0.2%)	16,182 (0.2%)	16,495 (0.4%)
Central Highlands Regional Shire	28,256 (2.7%)	32,359 (2.7%)	35,765 (2.0%)	39,264 (1.9%)	43,053 (1.9%)
Queensland	4,091,546 (2.4%)	4,428,138 (1.6%)	4,823,408 (1.7%)	5,211,995 (1.6%)	5,583,956 (1.4%)

When the Banana Shire Council and Central Highlands Regional Council boundaries are assessed at their pre-amalgamation LGAs, the general demographic profile from the 2006 census highlights the population distribution. The Mainland GTP RoW passes through southern Bauhinia and Duaringa shires; whereas the majority of the population in these two shires resides further to the north. Emerald Shire and Peak Downs Shire are well away from any GTP activities, and are accessed by a separate east-west highway system. They do have access via the Gregory Highway, but at a distance of over 250 km. For this reason, Emerald and Peak Downs will not be included in the GTP baseline as it is unlikely these areas will experience potential impacts from the project.

Table 11.5 General demographics profile of LGAs

Area*	2006 Population	Males		Females		Born O/S°	
		No.	%	No.	%	No.	%
Fitzroy SD	188,403	96,125	51.0%	92,278	49.0%	15,365	8.2%
Bauhinia (S)	2,190	1,211	55.3%	979	44.7%	85	3.9%
Duaringa (S)	6,744	3,722	55.2%	3,022	44.8%	435	6.5%
Emerald (S)	14,354	7,545	52.6%	6,809	47.4%	1,476	10.3%
Peak Downs (S)	3,188	1,767	55.4%	1,421	44.6%	216	6.8%
Banana (S)	13,361	6,962	52.1%	6,399	47.9%	859	6.4%
Queensland	3,904,534	1,935,381	49.6%	1,969,153	50.4%	17,616	8.2%

Source: ABS Basic Community Profiles, 2006 census data. Note: *SD = statistical division, S = shire and C = community; Born O/S = born overseas

The majority of Banana Shire's population is situated close to the Mainland GTP corridor. As seen in Table 11.5, there are approximately 13,361 people living in the shire, with the majority within 25 km of the proposed route. The route purposely transects an area to the north of the Banana Shire population corridor along the Dawson Highway in this area to reduce the impact on the local population.

Throughout all the old shires that make up the GTP study area, all are over represented by the male population, and this is a reflection of both the agriculturally dominated rural communities and the mining dominated communities (see Table 11.5). There is a slightly reduced number of people born overseas compared to the rest of Queensland except in Bauhinia and Emerald; Bauhinia is much less and more reflective of the South West SD while Emerald has a lot of mining activity and associated industry.

In Banana Shire Council in June 2007, 23.9% of persons were aged 0 to 14 years, 65.3% were aged 15 to 64 years and 10.8% were aged 65 years and over (see Table 11.6). In Central Highlands Regional Council at the same time, 24.7% of persons were aged 0 to 14 years, 69.9% were aged 15 to 64 years and 5.4% were aged 65 years and over (OESR, 2008a). Banana Shire had more children and people aged 25-44 than Queensland as a whole as did Central Highlands Regional Council. Central Highlands Regional Council did have very few people over 65+ as a reflection of the mining industry predominance in the Bowen Basin.

Table 11.6 Estimated resident population by age groups (years) by Local government area, Banana Shire Council and Central Highlands Regional Council, 30 June 2007

Local government area	Population by age									
	0–14		15–24		25–44		45–64		65+	
	number	%	number	%	number	%	number	%	number	%
Banana Shire Council	3,687	23.9	1,820	11.8	4,562	29.6	3,685	23.9	1,667	10.8
Central Highlands Regional Council	7,070	24.7	4,085	14.2	9,648	33.6	6,317	22.0	1,552	5.4
Queensland	844,941	20.2	592,761	14.2	1,188,308	28.4	1,043,912	25.0	511,509	12.2

Table note Based on ASGC 2006. Data for Reformed Local Government Area(s) are based on concordant Statistical Local Area data (ASGC 2006). The concordance is population based and has been derived from Planning Information and Forecasting Unit within the Department of Infrastructure and Planning.

Source Australian Bureau of Statistics, Population Estimates by Age and Sex, Australia and States (Cat. no. 3235.0.55.001)

Table 11.7 lists the family structure along the project area. Total couple families with children are more common along the project area than Queensland and the statistical division as a whole. This results in lower values in the other categories, and reflects the rural, family orientated lifestyle in these areas. The project area was shown to illustrate the differences from shire to shire along the Mainland GTP RoW.



Table 11.7 Family composition along the Mainland GTP RoW

Area	Total H/H		Total Family H/H		Total Couple Families with Children		Couple Family with Children under 15		Couple Family no Children under 15		Total One-Parent Families with Children		One-Parent Family with Children under 15		One-Parent Family no Children under 15		Other Family	
	No.		No.	%*	No.	%*	No.	%*	No.	%*	No.	%*	No.	%*	No.	%*	No.	%*
Fitzroy SD	64,710		48,111	74%	22,346	35%	16,800	26%	5,546	9%	7,190	11%	4,741	7%	2,449	4%	659	1%
Bauhinia (S)	800		569	71%	287	36%	227	28%	60	8%	49	6%	29	4%	20	3%	8	1%
Duaringa (S)	2,091		1,607	77%	879	42%	703	34%	176	8%	147	7%	110	5%	37	2%	17	1%
Emerald (S)	4,732		3,560	75%	1,885	40%	1,528	32%	357	8%	353	7%	225	5%	128	3%	45	1%
Peak Downs (S)	928		755	81%	463	50%	392	42%	71	8%	40	4%	21	2%	19	2%	4	0%
Banana (S)	4,716		3,508	74%	1,677	36%	1,322	28%	355	8%	389	8%	246	5%	143	3%	51	1%
Queensland	1,391,635		1,011,981	73%	446,740	32%	321,584	23%	125,156	9%	164,219	12%	98,071	7%	66,148	5%	17,221	1%

Note H/H is households

Source ABS 2006

11.3.4 Socio Economic Profile - General

Table 11.8 below gives data relating to employment within the project area.

Table 11.8 Employment within study area

	Total population 2006	Persons 15+		Total labour force	Part. Rate	Persons employed		Unemployment Rate
	No.	No.	%*	No.	%	No.	%	%
Fitzroy (SD)	188,403	145,008	77.0	91,753	63.3	87,627	95.5	4.5
Bauhinia (S)	2,190	1,688	77.1	1,291	76.5	1,265	98.0	2.0
Duaringa (S)	6,744	5,023	74.5	3,671	73.1	3,593	97.9	2.1
Banana (S)	13,361	10,131	75.8	7,057	69.7	6,889	97.6	2.4
Qld	3,904,534	3,097,995	79.3	1,915,947	61.8	1,824,997	95.3	4.7

Throughout the project area, the unemployment rate is less than half the State average. Employment rates ranged from 69.7 % to 76.5 %, well above the Queensland average of 61.8 %. The total labour force was lower than the Queensland average in all three shires, but the participation rate more than compensated for this as the persons employed averaged 97.8 % along the route and 95.3 % for the State.

Table 11.9 below gives information on the median weekly income for residents in the project area.

Table 11.9 Median weekly income

Area	Individuals 15+	Household
Fitzroy SD	\$481	\$1,067
Bauhinia (S)	\$557	\$1,056
Duaringa (S)	\$755	\$1,782
Banana (S)	\$528	\$1,143
Queensland	\$476	\$1,033

There are also a number of heavy industrial projects located towards the eastern end of the Mainland GTP corridor in the Gladstone region. Details regarding these industries are provided in Table 11.10 below.

Table 11.10 Major heavy industrial projects

Projects Underway	Projects Committed	Projects Under Investigation
Rio Tinto Alcan – Yarwun Alumina Refinery	Jemena Limited – Capacity building for Rio Tinto Aluminum’s Yarwun expansion	Arrow Energy Limited and AGL Limited (Joint venture) – High pressure gas pipeline development
Cement Australia – New Cement Mill	Origin Energy – Walloon coal seam gas fields development	Gladstone Ports Corporation Limited – Berth expansion on 153ha of reclamation adjacent to existing Fisherman’s Landing
Boyne Smelters Limited – Construction of new baking furnace and upgrade of crane runway	Wiggin Island Coal Terminal – Stage 1	Arrow Energy Limited – Boyne River coal seam gas exploration and appraisal
	Gladstone Pacific Nickel Limited – Stage 1 laterite nickel ore processing plant	Transpacific Industries Group Limited – Expansion of regional waste management facility

Projects Underway	Projects Committed	Projects Under Investigation
	Powerlink – infrastructure upgrades	Surat Basin Rail (SBR) ATEC DVR, Xstrata Coal Anglo Coal and QR – Dawson Valley railway development
	GLNG Operations GLNG Operations – Curtis Island LNG production facility development	Queensland Rail – Moura Link – Aldoga Rail project
	QGC LNG – Curtis Island LNG production facility development	Australian Inland Rail Expressway (AIRE) – inland railway to link
	Gladstone LNG Pty Ltd (LNG Ltd with Arrow Energy NL) – Fisherman’s Landing LNG production facility development	Gladstone Area Water Board – Gladstone – Fitzroy Pipeline project
		Queensland Energy Resource Limited (QER) – Oil Shale technology development facility
		Boulder Steel Limited – Blast furnace based steel plant development
		Southern Cross LNG (LNG Impel) – Curtis Island LNG production facility development
		Project Sun LNG (Soiitz Corp) – Fisherman’s Landing LNG production facility development

11.3.5 Socio economic profile – Indigenous

In considering the socio-economic status of Indigenous people within the project area, there are a number of regional catchments of which the main relevant catchment is CSG Field North which includes the settlements of Bauhinia, Emerald, Peak Downs, Duinga and Woorabinda

Woorabinda is the only Deed of Grant in Trust (DOGIT) community in the Mainland GTP corridor, and is considered separately to the remainder of the Indigenous population living in rural towns due to the particular socioeconomic characteristics of DOGIT communities.

Data in the following tables and charts within this section has been sourced from the Australian Bureau of Statistics Census 2006 Indigenous Community profiles (Cat. No. 2002.0 - 2006 Community Profile Series) unless otherwise indicated.

The principal towns in the project area include Springsure, Emerald, Clermont, Blackwater and the DOGIT community of Woorabinda. The profile that follows is based on the 2006 Census information for the local government areas (LGAs) that incorporate the towns.

Demographic profile

The 2006 Census information, summarised in Table 11.11 and Table 11.12, indicates that there are 1,699 Indigenous people in the project area, representing 1.3% of the Indigenous population in Queensland and 7% of the area's population (compared to Indigenous representation of 3.3% in the total Queensland population). About half of the Indigenous population reside in Woorabinda. The age profile of the Indigenous population is substantially younger than the non-Indigenous population which is consistent with the age profile for the whole of Queensland, with Woorabinda having a slightly younger age profile when compared to the remainder of the Indigenous population in the project area. Indigenous females comprised 52% of the Indigenous population (compared to females comprising 49% of the non-Indigenous population). These figures are based on the place of usual residence for a person, and do not include persons with cultural links to the project area but who do not reside in the area.

Table 11.11 CSG Fields North – Aggregate Population

	Indigenous			Non-Indigenous			Total		
	Males	Females	Persons	Males	Females	Persons	Males	Females	Persons
Total	850	849	1,699	12,688	11,165	23,853	13,538	12,018	25,556
% of Persons	50%	50%	7%	53%	47%	93%	53%	47%	100%

Source: ABS 2006 Census Indigenous Community Profiles. Does not include those whose status is not indicated

Table 11.12 Woorabinda Population

	Indigenous			Non-Indigenous			Total		
	Males	Females	Persons	Males	Females	Persons	Males	Females	Persons
Total	404	403	807	16	22	38	420	425	845

Source ABS 2006 Census Indigenous Community Profiles. Does not include those whose status is not indicated

11.3.6 Health

There are five medical and health facilities in the project area:

- Biloela Hospital (20 beds)
- Moura Hospital (10 beds)
- Theodore Hospital (13 beds)
- Springsure Hospital (12 acute and 10 long stay beds)
- Woorabinda Hospital (8 beds)

The capacities of these hospitals are detailed in Table 11.13.

Table 11.13 Hospitals in the project area

Facility	Current used beds / # of total beds	Services	Description
Biloela Hospital	10/20	Hospital	Medical, Surgical, Paediatric, Obstetric, Accident and Emergency, Palliative Care, Radiography, Pharmacy
		Specialist Services	Visiting: Ophthalmologist, General Surgery, Obstetric & Gyn, Mental Health, Drug and Alcohol, Orthopaedics
		Clinics Available	Dental, Midwives, Antenatal Clinic weekly, Venesection Clinic -weekly, Women's health Clinic - second monthly, Red Cross Emergency Donor Panel - monthly

Facility	Current used beds / # of total beds	Services	Description
		Allied Health Services	Physiotherapy, Speech and Occupational Therapy, Social Work
		Outreach Services	Child Health, Community Health, Aboriginal Health, Dental & Allied Health
		Other Aged Services	Long Stay & Respite Residential Care
Moura	2/10	Hospital	Medical, Surgical, Paediatric, A & E, Radiography, Pharmacy, Palliative Care
		Specialist Services	Visiting: Obstetrics and Gynaecology, Mental Health, Drug and Alcohol, Child Health
		Clinics Available	Visiting: Dental
		Allied Health Services	Visiting: Physiotherapy, Speech and Occupational Therapists, Radiography
		Other Aged Services	Respite Care
Springsure	Acute beds: 4/10 Long care beds: 12/12	Hospital	Acute Medical, Accident and Emergency, Ante Natal Care/Post Natal Care, Allied Health Services, SHACC Services, Operational Services -Housekeeping; Food Services; Ward Services, Post Surgical, Outpatient Clinic, Post Acute Care (wound care etc), Palliative Care, Nursing Home Type Patients, Pharmacy, Immunisation Clinic, X-Ray Service, Administration Services
Theodore	6/13	Hospital	Medical, Surgical, Paediatric, Obstetrics, Accident and Emergency, Palliative Care, Radiography, Pharmacy
		Specialist Services	Visiting: Drug and Alcohol, Child Health
		Clinics Available	Visiting: Dental
		Allied Health Services	Visiting: Physiotherapy, Speech and Occupational Therapy, Radiography
		Other Aged Services	Multipurpose Health Service, Respite Care and Community Care
Woorabinda	3/8	Services	Emergency, acute inpatient, residential care, community health services, oral health services, hostel care

Larger referral hospitals include Rockhampton Hospital and Richmond Health Care Centre.

The Royal Flying Doctor Service (RFDS) is also available to remote communities in the project area. There are eight bases scattered throughout Queensland, with the closest being Brisbane, Bundaberg, Charleville and Rockhampton. Flying doctors and emergency evacuations are determined by the emergency dispatch, which then coordinate regional resources to deal with the evacuations. Medical emergencies requiring patient extraction or situations where the temporary construction camp medical services cannot handle an emergency could require use of the RFDS or local ambulance services.

11.3.7 Emergency Services

The State Emergency Services (SES) is tasked with assisting people and communities in times of natural disasters and other emergency situations that affect portions or all of the community. The Central Region Rockhampton Area office is located in Rockhampton. This regional office covers the following areas:

- Banana SES Unit
- Bauhinia SES Unit
- Duaringa SES Unit
- Emerald SES Unit
- Gladstone/Calliope SES Unit
- Livingstone SES Unit
- Miriam Vale SES Unit
- Mount Morgan SES Unit
- Rockhampton/Fitzroy SES Unit
- Woorabinda Community SES Unit

Queensland Ambulance Service (QAS) presence along the Mainland GTP corridor is covered by the Central Region ambulance service, which extends from the Whitsunday Shire to the south of Miriam Vale and west to the South Australian border. The region covers approximately 440,000 km² and serves a regional population of approximately 320,000 people. The majority of the Mainland GTP RoW passes through this region. The service works closely with rescue helicopters based in Rockhampton and Mackay and with the RFDS fixed wing aircraft, also based in Rockhampton (Department of Emergency Services, 2008).

The Central Region has 37 urban fire stations and an operational staff of 161 full time and 451 auxiliary fire-fighters. Auxiliary stations can be found in Biloela, Moura, Springsure, Thangool, Taroom, Wandoan and Theodore. The Region's Fire Communications Centre is in Rockhampton (Department of Emergency Services, 2008). The temporary construction camp and work sites will have firefighting equipment; however, local authorities will be notified in the event of a serious fire.

Along the Mainland GTP corridor, the police operate from police stations in Biloela, Moura, Springsure, Theodore, Woorabinda and Duaringa.

11.3.8 Sport and recreation

As the Mainland GTP corridor includes mostly rural settlements, the need for recreation areas is less than in industrial towns; however, there are five parks and gardens in Moura and one park in Biloela.

Banana, Moura and Biloela all have Community Hall facilities. Furthermore, there are Youth Centres and Scouts/Guides huts in Biloela and Moura.

In Banana, there is a sporting ground. Moura has a swimming pool, skate park, bowls club, 18 sport clubs and additional activities like Shotokan Karate. There are 13 sporting facilities in Biloela, ranging from an aquatic centre to Magavalis Sports Complex. These facilities in Biloela are used by 25 associated sport clubs.

11.3.9 Community facilities and services

There are 11 child care facilities in five communities in the Central Queensland Region relevant to the project. These facilities have a combined capacity of 383 places. There were places available in all communities and it was indicated that capacity could be increased in many facilities if required. Most facilities interviewed said that many area residents had at least one stay-at-home parent, which resulted in a lower requirement for child care facilities in those communities. A local shopping centre can be found in Biloela. Additional supermarkets are located in Biloela and Moura.

There are 16 places of worship within the communities of Woorabinda, Biloela, Moura, Rolleston and Springsure in the vicinity of the Mainland GTP RoW. All of these places of worship are for the Christian faith.

Table 11.14 gives an overview of community facilities available in the Mainland GTP project area.

Table 11.14 Community facilities in the project area

Location	Venue	Name
Banana	Community Hall	Banana & District Community Hall
Biloela	Community Hall	Biloela Civic Centre
		Biloela Community Resource Centre
	Youth Centre	PCYC
	Scouts/guides hut	Girl Guides
		Scouts
	Showground	Biloela Showground
Moura	Community Hall	Moura Kianga Centre
	Youth Centre	Anglicare Impact Youth Centre
	Scouts/ guides hut	Moura Girl Guides
Rolleston	Community Hall	Rolleston Memorial Hall
Springsure	Community Hall	Springsure Memorial Hall
	Show Ground	Springsure Show Grounds - (camping; gas BBQ; basketball court, cricket pitch; multi-purpose oval; rugby league field, indoor cricket)

Table 11.15 below details cultural facilities present in the area surrounding the Mainland GTP project area.

Table 11.15 Cultural facilities in area surrounding the project area

Location	Type	Venue
Banana	Library	Mobile Library, weekly itinerary: Tuesdays Sutherland Hall: Week 1, 1.30 - 4.00 pm, Week 2, 12.00 - 1.00 pm then Banana School from 1.30 - 4.00 pm
Biloela	Library	Biloela Library
	Museum	Queensland Heritage Park
	Art Gallery	Biloela Community Arts House
	Theatre/performing arts venue	Biloela Civic Centre

Location	Type	Venue
Moura	Library	Banana Shire Library Moura
	Museum	Moura Information Centre & Museum
	Theatre/performing arts venue	Art Gallery in Moura

11.3.10 Community values, vitality, lifestyle and wellbeing

As detailed previously, much of the Mainland GTP RoW intentionally bypasses populated areas and environmentally sensitive areas to minimise potential impacts. As a result, most of the population along the Mainland GTP corridor will experience little to no direct impacts. There is some potential for minor disruptions to daily activity as a result of construction activities including:

- Temporary traffic delays
- Temporary restriction of access
- Temporary increase in people in the general area
- Temporary increase in traffic

As the length of the Mainland GTP RoW is approximately 406 km, the assessment of community values, vitality, lifestyle and wellbeing for communities along the GTP corridor is diverse. Starting from the western end of the Mainland GTP corridor, for the most part the communities (both identifiable towns and areas of dispersed settlement such as the Arcadia Valley) tend to be more representative of communities with a greater emphasis on rural values. For the eastern end of the Mainland GTP corridor, there is a gradual transition from a rural community orientation to a more urban orientation as the GTP nears the coast. Although the Mainland GTP RoW remains within the former Calliope Shire (now Gladstone Regional Council), the properties become smaller and therefore more numerous in this area due to proximity to Gladstone.

For the Mainland GTP RoW, the changes in land use along the RoW have an effect on the local setting. In the Fairview area, the industry is predominantly beef. The Arcadia Valley is predominantly under cultivation, before returning to mainly beef closer to Rolleston. The Moura area is predominantly beef, although cotton is quite common also. This is continued through to Gladstone Regional Council, where the area becomes more urban and properties smaller as previously discussed. The properties are smaller with good quality soils and are therefore able to sustain small herds and cotton cultivation. The abundance of cattle rather than cultivation along the GTP corridor is a reflection of the soil quality in various locations, as well as the topography and access to irrigation.

Throughout the majority of the Mainland GTP corridor, the population is classified as rural, with strong ties to family, the land and the community. There are few physical communities along the GTP corridor, with the majority focussed around Moura. The Mainland GTP RoW around Moura was situated north of the Dawson Highway in order to avoid the population build up there. At the western end, Arcadia Valley does not have a physical community centre; however, there is a sense of community in the valley, with similar feelings toward industry and community shared throughout. This is a good reflection of the community bond shared by many people living in the rural regions of Queensland.

There are various levels of social infrastructure and services along the GTP corridor, with the majority being located in the major centres. People from the more remote or smaller communities (as well as those on homesteads and farms) are generally required to travel to these centres for many services. This has always been required in the region, being a part of the social fabric of neighbours looking after neighbours and a general self/family reliance for many people isolated from communities. Access can be difficult for some, particularly the poor and elderly with limited mobility or access to transportation. In the case of the elderly, the low numbers of people over 65 reflects the long-term trend of the elderly leaving the area for better access to services in the larger centres.

The area along the Mainland GTP corridor has also experienced varying degrees of impact as a result of recent droughts up to present. This has resulted in many people leaving the area permanently, as well as children leaving for schooling or other opportunities outside the area and not returning. As a result, while much of Queensland is growing at a reasonable pace, much of the project area populations are relatively stagnant or experiencing slight declines. Although the Central Highland area is projected to increase above the Queensland average to 2026, it is important to note that the majority of the population lives over 200 km north of the Mainland GTP RoW and is not reflective of the population in the region adjacent to the GTP. The population adjacent to the GTP corridor is experiencing more of the population changes associated with Banana Shire Council.

Many populations may be stagnant in number but experiencing the ageing of their residents. Thus, in the next few generations they could experience rapid population declines as people move to retire or pass away with no population inflow or natural increase. This is a reality of much of the rural landscape being badly affected by the drought, combined with a changing societal trend toward urbanisation. The areas with greater diversity of industries (like Moura, which has cotton, cattle and coal) tend to be better insulated from negative change than the areas with single industries.

11.4 Potential adverse or beneficial impacts on existing community values (construction and operation)

The majority of the potential Mainland GTP RoW impacts will occur on the directly affected individual properties along the route. The assessment also considered the population not directly affected by the proposed project area, as the route passes close to several communities and homesteads, and also goes near or under major roads used by the general public. As construction is short term, potential impacts are only expected to occur for brief periods of time. As such, many impacts are rated at a lower level than in the CSG field or at the LNG facility, due to the short duration that any one group or individual will be exposed. Due to the size of the workforce and the duration of time they will be working in any given area (generally 2 months), there will be both positive and potentially negative impacts associated with the construction and operation phases of the Project.

GLNG Operations will maintain a Social Impact Management Plan (SIMP) and ensure the plan evolves with the on-going construction process. This is intended to reduce the risk of repeating mistakes as well as making sure relevant information relayed to land managers by landholders is available to construction crews.

11.4.1 General potential social and community impacts

The potential community and social impacts are anticipated to primarily occur during the construction period, and to a much lesser extent during the operational and decommissioning stages. Previous pipeline construction in 1989 along much of the same RoW was considered in the assessment, including the apparent absence of long-term or cumulative social effects as a result. During operations, the workforce is anticipated to be approximately 20 individuals throughout the entire RoW, and therefore is not expected to be significantly noticed above the normal background movements in the area. Therefore, for the purposes of this assessment, the focus is on the construction phase unless otherwise stated.

For the construction phase of the Mainland GTP RoW, a large component of the mitigation proposed is an effective communication strategy for the local communities and landholders. This strategy will be designed to better inform the communities of the potential impacts or disruptions to their daily lives during times of activity, as well as the potential opportunities for employment and services. This will allow people to better understand upcoming project activities and will assist them to plan around these as much as possible.

The key social and community impacts associated with construction of the Mainland GTP RoW primarily impact on landholders within the Mainland GTP RoW. Impacts to people and the community within the Mainland GTP corridor and broader project area are not expected to be significant for the following reasons:

- The construction activities are anticipated to occur in a specific area for less than two months before moving to the next area
- The majority of the Mainland GTP RoW is located away from the general population centres
- The majority of the Mainland GTP RoW is located away from the major transportation corridors
- Construction management plans (including traffic control, noise and dust suppression where possible and scheduling certain events around community activities if possible) will be implemented to coordinate construction activities with daily community routines

The latter is addressed in the landholder negotiations prior to construction. In circumstances where unforeseen effects occur, GLNG Operations will implement a grievance mechanism in order for complaints to be lodged and responded to in a reasonable manner.

A key component that forms part of the social and community mitigation strategy is an effective SIMP that addresses local community and landholders concerns. GLNG Operations will be implementing a SIMP for the Project to address the social and community impacts that could result from the Project.

11.4.2 Potential impact on demographic profile

As detailed in Chapter 2, the total peak workforce is expected to be 900 (850 contractors and 50 GLNG Operations staff). Construction camps will be sized to accommodate approximately 450 persons at main camps and 200 persons at behind and advanced camps. Four construction camps will be located along the Mainland GTP RoW in areas that minimise travel distance to the work sites. Based on the assertion that construction workers will be housed in temporary construction camps (and therefore will not move into the communities along the RoW), there are no anticipated impacts on the project area's demographic profile.

There is no anticipated population increase associated with construction or operations. The construction workforce will be housed in construction camps for only short periods of time.

Similarly, the operations workforce will not impact on the demographic profile of the project area.

11.4.3 Potential impact on employment

GLNG Operations policy aim is to employ locals wherever possible. For the construction phase of the Mainland GTP RoW, this will not always be possible as there are certain skills required for pipe construction which may not be readily found in Gladstone or regional surrounding communities.

There may be opportunities for local employment for some components, like traffic controllers, graders, earth moving equipment operators and general labourers. The exact numbers and types of employment opportunities for people in the RoW will be dependent on the Contractor's requirements and in-house capabilities. GLNG Operations will encourage the contractor to employ locally whenever possible.

Unemployment levels for old shires within the councils were 0.6% to 3.7% in Roma Regional Council, 4.2% to 5.4% in the Gladstone area and 1.7% to 2.4% in the rural areas between (Bauhinia, Duaringa and Banana) according to the most recent data available. This indicates a strong employment rate for the rural areas (including Roma Regional Council, which is less reliant on employment opportunities associated with the GTP) and an employment opportunity for those unemployed in the Gladstone Regional Council. Since the potential local employment opportunities are anticipated to be minor, there is not likely to be a measurable impact on the project area's employment rates associated with construction of the Mainland GTP RoW.

11.4.4 Potential impact on Indigenous socio economic profile

Table 11.16 presents the potential social impacts to the Indigenous communities across the Mainland GTP corridor. The impacts are discussed within the matrix for each phase of the project, including a pre-construction phase which includes the EIS process. GLNG Operations will examine the potential impacts from decommissioning and closure closer to the event, to better assess the potential impacts and suitable mitigation strategies.

Table 11.16 Impact matrix for Indigenous project areas

Spatial Boundary	Temporal Boundary		
	Pre-construction	Construction	Operations
CSG Field North (relevant to western section of Mainland GTP RoW)	Inter-family and inter-group stress induced by negotiations for ILUAs over the GTP RoW and CHMPs over the gas fields, pipeline and LNG facility areas Anxiety concerning the protection of significant sites, even where these are not known with certainty	Potential impacts on cultural heritage to be managed through the CHMP negotiated Social friction due to the presence of a large number of construction workers, some with attitudes that are intolerant of Indigenous people Inability to secure employment opportunities due to lack of job readiness (addressed through Santos Aboriginal Engagement policy)	Potential impacts on cultural heritage to be managed through the CHMP negotiated Inability to secure employment opportunities due to lack of job readiness (addressed through Santos Aboriginal Engagement policy)

Spatial Boundary	Temporal Boundary		
LNG Facility (relevant to eastern section of Mainland GTP RoW)	<p>Inter-family and inter-group stress induced by negotiations for ILUAs over the GTP RoW and CHMPs over the gas fields, pipeline and LNG facility areas</p> <p>Anxiety concerning the protection of significant sites, even where these are not known with certainty</p>	<p>Potential impacts on cultural heritage to be managed through the CHMP negotiated</p> <p>Social friction due to the presence of a large number of construction workers, some with attitudes that are intolerant of Indigenous people</p> <p>Inability to secure employment opportunities due to lack of job readiness (addressed through Santos Aboriginal Engagement policy)</p> <p>Impaired ability to access private rental and home ownership market</p>	<p>Inability to secure employment opportunities due to lack of job readiness (addressed through Santos Aboriginal Engagement policy)</p> <p>Impaired ability to access private rental and home ownership market</p>

11.4.5 Potential impact on income and affordability

The construction of the Mainland GTP RoW is for a short duration (generally less than two months in any one location). The level of income for locals who successfully gain employment with the construction crews would likely increase, as the construction salaries are anticipated to be at or above the average incomes along the Mainland GTP corridor (with the exception of Duaringa, which is already well above neighbouring regions mainly due to coal mining activities in the area). This may have an impact in some communities however the number of local residents hired is anticipated to be low, and as such impacts to incomes on the study area is expected to be insignificant.

11.4.6 Potential impact on housing and accommodation

The entire workforce will be accommodated in a series of temporary construction camps. Locations for these facilities are outlined in Chapter 3. No significant impacts on local housing and accommodation are anticipated.

There may be occasions when senior project staff or some contractors are accommodated in local hotels or motels throughout the construction phase. This is not expected to be a common occurrence since the temporary construction camps will be utilised where possible.

11.4.7 Potential impact of mosquito and biting midges

There is the potential for a localised increase in the population of mosquitoes and biting midges to occur during Mainland GTP construction. This is due to the potential for increased areas of standing water during trenching of the Mainland GTP RoW.

However to minimise this potential impact, a Mosquito and Midge Management Plan (MMMP – see Appendix E) will be developed and implemented prior to construction. It is therefore unlikely that any temporary increase in the population of mosquitoes and biting midges will be experienced within the Mainland GTP RoW construction site.

11.4.8 Potential impact on education and training

The construction personnel for the Mainland GTP RoW will be highly skilled and will not require additional training or education for this phase of the Project. Operational personnel required for the operational phase will be trained by GLNG Operations. As such construction of the Mainland GTP is not expected to create a demand on education and training facilities within the area.

11.4.9 Potential impact on health and emergency services

First-aid facilities will be available at the Mainland GTP RoW work sites and at the temporary construction camps. The facilities will have the capacity to treat non-serious injuries and stabilise more serious injuries prior to transport to hospitals. Serious injuries would often be referred to larger hospitals including Gladstone, Rockhampton or Emerald hospitals.

The construction personnel of the Mainland GTP RoW are not anticipated to have a significant demand on general health and medical services in the region. This could include fire, police, ambulance or flying doctor. Due to the on-site capabilities of the emergency services for the construction personnel, a request for local emergency services is considered a low likelihood. Should such services be requested, it is unlikely that the temporary use of those services would adversely affect the community.

GLNG Operations will inform the local emergency services in an area prior to undertaking construction activity as to the size of the workforce, on-site capabilities and emergency procedures.

11.4.10 Potential impact on community facilities and services

The temporary construction camps will be self sufficient, including recreational facilities and full accommodation (including meals), and so the workforce is not anticipated to have an impact on these services locally. Workers may venture into some of the communities for the occasional purchase, but this is not anticipated to negatively affect activities in the community. The economic activity associated with such activities will have a positive impact on local businesses, although this is not anticipated to be significant, due to the construction duration, workforce size and self contained temporary construction camps.

GLNG Operations will explore the potential for procuring some supplies locally where possible in order to increase local economic and employment opportunities.

11.4.11 Potential impact on community values and lifestyle

The impacts on the community values and lifestyle within Mainland GTP corridor and broader project area are expected to be minor due to the duration of construction, remoteness of the construction site itself and the minor local employment opportunities.

11.4.12 Operational impacts

The operational workforce is anticipated to be approximately 20 persons. Operational activities will include monthly inspections along the Mainland GTP RoW by vehicle and foot patrols to check on the condition of the GTP and associated infrastructure. Maintenance of the Mainland GTP will be carried out by light vehicles and small maintenance crews on an annual basis, or as and when required. Social and community related impacts from these operational activities are expected to be low and manageable due to the low number of vehicles movements, infrequent maintenance activities and remoteness of the majority of the Mainland GTP RoW.

Furthermore, all activities and works associated with these operational activities will be in accordance with the Operational Management Plan (OMP), which will be developed and implemented prior to the completion of the construction phase.

11.5 Cumulative impacts

The cumulative social and community impacts relate specifically to the impacts of the construction of the Mainland GTP's, and do not include the cumulative social impacts for the Marine Crossing and Curtis Island GTP and Curtis Island LNG Plant caused by development in the area. This cumulative impact assessment is based on the impact scope, identification and scoring methodology described in Chapter 2 of this EM Plan.

11.5.1 Social and community (construction worker employment)

The anticipated number of workers for the construction phase includes:

- GLNG – approximately 900
- APLNG – approximately 800 workers
- QCLNG – approximately 500 workers.

Due to constraints on availability of local workers, the construction workforce will be predominantly sourced from other parts of Queensland, Australia and internationally.

The construction of the GTPs on the mainland will have a neutral to positive temporary impact on employment and skills training. However, given the limited scale and duration of the works, positive impacts are likely to be minor.

Local labour shortages may however arise at times of maximum demand for construction, if two or more pipelines are being constructed in relatively close proximity at the same time. Given the lack of availability of an appropriate local labour force, due to the sparsely populated terrain that the pipeline corridor traverses, there is insufficient labour to construct the pipelines using locals labour. Consequently the large majority of labour will have to be imported from outside the local area, or even from outside the State.

This would have mixed advantages and disadvantages. The disadvantages relate to the skewing of the local labour force towards temporary, relatively unskilled labour. Workers and their families would require additional educational, health or other services. The benefits would relate to the need to provide accommodation, subsistence, entertainment etc for imported labour, with an attendant secondary effect on spend rates in the local economy, mainly greater primary spend on retail and other outlets. This in turn will give rise to further, local employment.

There will be positive cumulative employment impacts, minor negative cumulative pressures on local services and major negative implications on transport and traffic resulting from construction worker employment (if these are implications are not addressed).

Potential additional mitigation measures that will be considered during the preconstruction and construction phases of the Project are:

- The Project has taken a proactive approach to the management of social and community impacts. A Social Impact Management Plan (SIMP) was submitted in September 2010 in response to the CG's call for more detail in the management of social impacts
- GLNG Operations recognises that solutions to cumulative social and community impacts must be achieved through cooperation in government initiatives, engaging a wide range of stakeholders

- The Coordinator General's report sets out a number of conditions requiring participation in joint studies and groups to address cumulative impacts including:
- Road Transport Infrastructure Cumulative Impacts Study
- Industry Leadership Group for CSG Resource Projects to provide linkages to the Regional Community Consultative Committees (RCCCs)
- Project Housing Strategy for the project in consultation with other major project proponents, Councils and the Department of Communities
- Liaise with local health emergency services to coordinate strategic emergency response plans
- Provide self-sufficient temporary accommodation facilities for pipeline construction
- Ensure construction personnel use the temporary facilities provided for the project

11.5.2 Social and community (income and cost of living/housing and accommodation/values and lifestyle/demographic profile)

Most of the construction is located away from major population centres and infrastructure corridors, which will minimise impacts to social and community aspects of the region from an influx of temporary construction.

Key impacts are anticipated to be:

- Increased cost of living to local residents due to higher average income.
- Increased demand for housing, services and infrastructure due to a high influx of construction workers.
- Alterations to the community values as a result of an increased influx of up to 5,500 people for the construction phase of the pipelines, most of whom will be from interstate or foreign countries.
- Changes to the demographic profile of the local community from the increase in the construction workforce, which will be predominantly younger males.

In addition, nearly all construction workers for the projects will be housed in self-sufficient temporary accommodation facilities (TAFs) that will be located away from major population centres. The following number of TAFs are proposed for each project:

- GLNG - two to three main and two to three satellite TAFs
- APLNG – one main and several satellite TAFs (APLNG EIS, 2010)
- QCLNG – three TAFs (QCLNG EIS, 2009).

Based on the assumption that all TAFs for the projects will be self-sufficient for resources, health services and entertainment, the potential for impacts to social and community impacts on accommodation is limited.

In addition, the timeframe for the construction of the pipeline RoWs on the Export GTPs could be between 2 to 4 years in total and 6 weeks to five months in any given area.

Therefore cumulative impacts to income and cost of living, housing and accommodation, lifestyle values and demographic profile will be minor.

There will be minor negative cumulative impacts on social and community (income and cost of living/housing and accommodation/values and lifestyle/demographic profile).

Potential additional mitigation measures that will be considered during the preconstruction and construction phases of the Project are:

- The Project has taken a proactive approach to the management of social and community impacts. A Social Impact Management Plan (SIMP) was submitted in September 2010 in response to the CG's call for more detail in the management of social impacts

- GLNG Operations recognises that solutions to cumulative social and community impacts must be achieved through cooperation in government initiatives, engaging a wide range of stakeholders
- The Coordinator General's report sets out a number of conditions requiring participation in joint studies and groups to address cumulative impacts including:
 - Road Transport Infrastructure Cumulative Impacts Study
 - Industry Leadership Group for CSG Resource Projects to provide linkages to the Regional Community Consultative Committees (RCCCs)
- Project Housing Strategy for the project in consultation with other major project proponents, Councils and the Department of Communities
- Liaise with local health emergency services to coordinate strategic emergency response plans
- Provide self-sufficient temporary accommodation facilities for pipeline construction
- Ensure construction personnel use the temporary facilities provided for the project

11.5.3 Social and community (health)

Generally, cumulative impacts will be minor given that the projects will provide self-sufficient TAFs along the pipeline corridors. Each facility will be able to treat minor incidents and prepare patients for transport to a hospital if required.

It is assumed that each proponent will ensure medical screening for all international workers, which will ensure that cumulative impacts to local communities is minimised.

There will be negligible cumulative impacts on social and community (health).

Potential additional mitigation measures that will be considered during the preconstruction and construction phases of the Project are:

- The Project has taken a proactive approach to the management of social and community impacts. A Social Impact Management Plan (SIMP) was submitted in September 2010 in response to the CG's call for more detail in the management of social impacts
- GLNG Operations recognises that solutions to cumulative social and community impacts must be achieved through cooperation in government initiatives, engaging a wide range of stakeholders
- The Coordinator General's report sets out a number of conditions requiring participation in joint studies and groups to address cumulative impacts including:
 - Road Transport Infrastructure Cumulative Impacts Study
 - Industry Leadership Group for CSG Resource Projects to provide linkages to the Regional Community Consultative Committees (RCCCs)
- Project Housing Strategy for the project in consultation with other major project proponents, Councils and the Department of Communities
- Liaise with local health emergency services to coordinate strategic emergency response plans
- Provide self-sufficient temporary accommodation facilities for pipeline construction
- Ensure construction personnel use the temporary facilities provided for the project

11.5.4 Social and community (emergency services)

Cumulative impacts may arise from multiple projects to existing emergency services.

It is assumed that all projects will have suitable Safety Management frameworks in place for the pipeline construction. Consequently the likelihood of a significant health and safety incident occurring from the construction of the pipelines is considered low.

In the instance of a natural disaster, the capabilities of emergency services could be exceeded if construction of multiple projects were occurring in the same area. This would include pressure on the Gladstone, Biloela and Rockhampton hospitals, Queensland Fire and Rescue Service and State Emergency Services.

There will be minor negative cumulative impacts on social and community (emergency services).

Potential additional mitigation measures that will be considered during the preconstruction and construction phases of the Project are:

- The Project has taken a proactive approach to the management of social and community impacts. A Social Impact Management Plan (SIMP) was submitted in September 2010 in response to the CG's call for more detail in the management of social impacts
- GLNG Operations recognises that solutions to cumulative social and community impacts must be achieved through cooperation in government initiatives, engaging a wide range of stakeholders
- The Coordinator General's report sets out a number of conditions requiring participation in joint studies and groups to address cumulative impacts including:
 - Road Transport Infrastructure Cumulative Impacts Study
 - Industry Leadership Group for CSG Resource Projects to provide linkages to the Regional Community Consultative Committees (RCCCs)
- Project Housing Strategy for the project in consultation with other major project proponents, Councils and the Department of Communities
- Liaise with local health emergency services to coordinate strategic emergency response plans
- Provide self-sufficient temporary accommodation facilities for pipeline construction
- Ensure construction personnel use the temporary facilities provided for the project
- Liaise with local health emergency services to coordinate strategic emergency response plans

11.5.5 Social and community (local services and facilities)

Some additional demand for local services and facilities is likely to be generated by multiple projects occurring in the same area, especially during the timeframe that construction of the pipelines occurs concurrently. However, self-sufficient temporary construction accommodation facilities will be provided for workers along the pipeline route, minimising potential impacts to local facilities.

Given the limited scale and duration of the works, and the very large scale of works associated with other components of the LNG projects, these impacts are likely to be minor.

There will be minor negative cumulative impacts on social and community (local services and facilities).

Potential additional mitigation measures that will be considered during the preconstruction and construction phases of the Project are:

- The Project has taken a proactive approach to the management of social and community impacts. A Social Impact Management Plan (SIMP) was submitted in September 2010 in response to the CG's call for more detail in the management of social impacts
- GLNG Operations recognises that solutions to cumulative social and community impacts must be achieved through cooperation in government initiatives, engaging a wide range of stakeholders

- The Coordinator General's report sets out a number of conditions requiring participation in joint studies and groups to address cumulative impacts including:
 - Road Transport Infrastructure Cumulative Impacts Study
 - Industry Leadership Group for CSG Resource Projects to provide linkages to the Regional Community Consultative Committees (RCCCs)
- Project Housing Strategy for the project in consultation with other major project proponents, Councils and the Department of Communities
- Liaise with local health emergency services to coordinate strategic emergency response plans
- Provide self-sufficient temporary accommodation facilities for pipeline construction
- Ensure construction personnel use the temporary facilities provided for the project
- Provide self-sufficient temporary accommodation facilities for pipeline construction
- Ensure construction personnel use the temporary facilities provided for the project

11.5.6 Social and community (construction vehicle movements/construction pressure on local services)

The construction of the GTPs will result in a substantial increase in road traffic, primarily resulting from the transport of pipeline components to the site. The projects are likely to use the same general road network to transport pipe from Brisbane and Gladstone.

Multiple projects occurring at the same time will result in cumulative impacts to the road network given the number of heavy vehicles that will be using the roads. Impacts will arise to the quality of the roads and the safety of intersections

Multiple projects occurring at the same time may require the class of some roads to be upgraded, particularly secondary roads, in order to accommodate the significant increase in the number and size of trucks that will be using the road network.

Traffic congestion may also increase as a result of multiple projects through increased traffic and delays on roads from construction works. Cumulative impacts will arise, particularly around the common infrastructure corridor in the GSDA if the construction schedules overlap.

Personnel will be transported to site primarily by bus. Construction crew for the projects will be flying in to common airports, including Gladstone and Biloela airports. Cumulative impacts may occasionally cause unavailability of flights due to increased demand. This is expected to be short term depending on the scheduling of project construction phases.

There will be moderate negative cumulative impacts on social and community (construction vehicle movements/construction pressure on local services). Potential additional mitigation measures that will be considered are:

- Participate in a road transport infrastructure cumulative impacts study

11.6 Environmental protection commitments, objectives and control strategies – social (construction and operation)

The conditions in Appendix 1, Part 3 of the CG Report impose requirements to manage the social impacts of the GLNG Project. In accordance with those conditions, measures are being taken to manage the social impacts of the GLNG Project (including the Mainland GTP).

The management measures as outlined in Table 11.17 below will be implemented.

Table 11.17 Mitigation measures for the management of social and community

Item	Detail
Environmental Protection Objective	<ul style="list-style-type: none"> To minimise any social disruption to the local communities from the construction of the Mainland GTP RoW
Specific Objectives	<ul style="list-style-type: none"> No warranted complaints from landholders and the community, and warranted complaints responded to within 2 working days To prevent the occurrence of potential mosquito and biting midge breeding sites and the presence of adult mosquitoes and biting midges
Control Strategies	<p>Preconstruction phase</p> <ul style="list-style-type: none"> Prior to construction, develop a draft Social Impact Management Plan (SIMP) consistent with the Social Impact Assessment Unit, Department of Infrastructure and Planning draft guidelines and template requirements, for review by the Coordinator-General prior to release. The SIMP will address the following: <p><i>Employment</i></p> <ul style="list-style-type: none"> Prioritise local employment over non-local employment where possible and practical <p><i>Income and affordability</i></p> <ul style="list-style-type: none"> Adopt local procurement policies in order to enhance local economic benefits Where possible explore the potential to procure some supplies locally if possible <p><i>Health</i></p> <ul style="list-style-type: none"> Inform local health services prior to commencing activity in the area <p><i>Heritage</i></p> <ul style="list-style-type: none"> Minimise social impacts on indigenous persons in the project area by the implementation of the Proponents Aboriginal Engagement Plan <p><i>Emergency services, Strain on local facilities and services</i></p> <ul style="list-style-type: none"> Inform local emergency services prior to commencing construction Maintain an open dialogue with local service providers to understand the likely future demand for infrastructure and services <p><i>Community values, lifestyle</i></p> <ul style="list-style-type: none"> Contribute to local liveability programs and initiate a community consultation and awareness campaign to promote project benefits to the community Unless otherwise negotiated with the landholder, GLNG Operations will ensure that burial and placement of GTP will not adversely impact on existing landholder management practices <p><i>Consultation strategy</i></p> <ul style="list-style-type: none"> Prior to construction GLNG Operations will liaise with relevant landholders and the Department of Primary Industries and Fisheries to allow for the removal of potentially affected millable timber on private and State owned land GLNG Operations will maintain an open dialogue with local councils which will help local service providers understand the likely future demand for infrastructure and services GLNG Operations will consult with: <ul style="list-style-type: none"> All affected parties should the proposed pipeline alignment create any potential short or long term impact to the Yarwun Resource DTMR on the proposed crossing of Dawson Valley Branch railway Queensland Energy Resources Limited (QER), DLGP and other LNG proponents with respect to the pipeline alignment across oil shale reserves Anglo Coal to ensure that the alignment of any pipeline easement across Anglo Coal mining tenements takes into account the interest of all parties Council and community representative groups to discuss the GTP construction program, operations, and decommissioning and rehabilitation <p><i>Housing and accommodation</i></p> <ul style="list-style-type: none"> Temporary accommodation will comply with the Queensland Development Code Part MP 3.3 Temporary Accommodation Buildings and Structures (1 July 2010) draft, until the code is finalised The Contractor will ensure and demonstrate that all temporary workers' accommodation is located, where practical, above the Q50 flood level Workers' accommodation will be located to the satisfaction of the DERM and have regard

Item	Detail
	<p>to potential noise emissions in accordance with Draft State Planning Policy: Air, Noise and Hazardous Materials</p> <ul style="list-style-type: none"> • Sewage treatment plants associated with temporary workers' accommodation must be located above Q50 flood levels • Prior to commencement of construction the Contractor will submit to the Proponent and all relevant local governments, a proposal and mitigating measures that satisfy local and regional requirements • Provision of food in the workforce accommodation facilities will be in compliance with the Food Act 2006 <p>Construction</p> <ul style="list-style-type: none"> • Implement the SIMP developed during the preconstruction phase to monitor and communicate social impacts associated with the construction of the Mainland GTP section and work with local services and stakeholders to develop practical solutions • Ongoing consultation with the community, agencies and representative groups to discuss the Mainland GTP construction program, operations, and decommissioning and rehabilitation • Implement the MMMP, which typically addresses (refer Appendix E for MMMP)) <ul style="list-style-type: none"> – Depressions in the ground surface (such as wheel ruts) will be filled as soon as practicable to prevent the ponding of water – Pools of stagnant water will be drained and/or the depressions filled – Storage containers capable of ponding water will be either discarded after use or stored in an inverted position (care will be taken to ensure that ponding does not occur in waste storage areas) – Erosion and washdown practices will be controlled to prevent the formation of standing water pools in natural water courses adjacent to the sites – Staff will be trained to recognise mosquito and biting midge breeding activity and the treatment of breeding sites – An assessment of work areas will be undertaken prior to works and on an ongoing informal basis to identify potential breeding sites – Workforce accommodation facilities to be fitted with protective barriers, such as fly screens and air conditioning – Insect repellent will be made available to personnel as required – Any required specific area control plans based on assessment of potential breeding sites will conform to the DERM's Mosquito Management Code of Practice for Queensland – Queensland Health and the relevant local councils will be contacted for assistance in choosing a suitable method of laticiding / eradication should this be necessary <p>Operational phase</p> <ul style="list-style-type: none"> • Typical mitigation and controls for the operational phase of the Project will be detailed in the Operational Management Plan, which will be developed prior to construction.
<p>Performance Indicators</p>	<ul style="list-style-type: none"> • No warranted complaints from landholders and the community, and warranted complaints responded to within 2 working days

12. Heritage

12.1 Chapter summary

This section provides a summary of the potential impacts that the Mainland GTP may have on existing indigenous and non-indigenous heritage values and proposed mitigation measures detailed throughout the chapter.

12.1.1 Summary of heritage values:

- There have been numerous Aboriginal cultural heritage sites identified along the Mainland GTP RoW. The most common site types have been:
 - Stone artefacts, as isolates and in scatters, particularly in association with creeks and rivers
 - Open camp sites, also in association with creeks or rivers
 - Scarred trees in areas of remnant vegetation
- One art site has been identified in the vicinity of the Mainland GTP but outside of the RoW area.
- There are two archaeological and six heritage sites of non-indigenous value located in the Mainland GTP project area but outside of the RoW.
- No burials or human remains have been located during the surveys

12.1.2 Summary of potential impacts to indigenous and non-indigenous values:

Construction

For Indigenous heritage values, each of the seven Cultural Heritage Management Plans (CHMPs) in place for the Mainland GTP RoW includes detailed provisions to deal with the management of impacts to Aboriginal cultural heritage sites.

Management of impacts to each site has been agreed on a case-by-case basis with each group. Identified artefacts that would have been impacted by construction of the Mainland GTP RoW have been relocated with the consent of the relevant Aboriginal group. During construction, there will be monitoring of earthworks by group representatives in areas of high heritage sensitivity or where sub-surface archaeological deposits are likely.

Infrastructure within the Mainland GTP RoW will be located to avoid known non-indigenous sites. In the event that a site is identified during construction it shall be demarcated and access restricted where construction works are close to the heritage site. Any impact to other sites of local significance will be minimised unless absolutely essential.

Operation

Operational activities will typically include monthly inspections along the Mainland GTP RoW by vehicle and foot patrols to check on the condition of the GTP and associated infrastructure. Maintenance will be carried out by light vehicles and small maintenance crews on an annual basis, or as and when required. Cultural heritage (indigenous and non-indigenous) related impacts from these operational activities will be managed in accordance with the relevant CHMP and OMP, which will be developed and implemented prior to the completion of the construction phase.

12.1.3 Summary of proposed mitigation measures for heritage values

Table 12.1 Proposed mitigation measures for the management of heritage

Item	Detail
Environmental protection objective	<ul style="list-style-type: none"> To protect the cultural heritage values of the GTP RoW
Specific objectives	<ul style="list-style-type: none"> Compliance with the requirements of the Aboriginal Cultural Heritage Act 2003 and the relevant Cultural Heritage Management Plans (CHMPs) No disturbance of any place on the Queensland Heritage Register in accordance with the requirements of the Queensland Heritage Act 1992
Control strategies	Refer to Table 12.5 for heritage values management control strategies to be implemented during construction and operation of the Mainland GTP.
Performance indicators	<ul style="list-style-type: none"> Compliance with the requirements of the Aboriginal Cultural Heritage Act 2003 and the relevant Cultural Heritage Management Plans (CHMPs) No disturbance of any place on the Queensland Heritage Register in accordance with the requirements of the Queensland Heritage Act 1992

12.2 Description of environmental values

Searches of the following databases were undertaken to identify Indigenous and non-Indigenous sites within the vicinity of the Mainland GTP RoW.

Table 12.2 Mainland GTP database searches

Governing body	Database
DERM	Aboriginal and Torres Strait Islander Cultural Heritage Database and Register
DERM	Queensland Heritage Register (QHR)

In addition to the above searches, detailed on-site cultural heritage surveys were also undertaken along the GTP RoW to identify any additional heritage sites that may be found within the RoW over and above to what has been accounted for in both state and local databases. Further details regarding these surveys are provided throughout the remainder of this chapter.

12.2.1 Indigenous

Potential sites

The nature and distribution of many forms of Indigenous cultural heritage in a landscape is in part associated with environmental factors such as geology, climate and landforms which affect the availability of plants, animals and water, the location of suitable camping places and suitable surfaces upon which rock art could be created. Such environmental factors also affect the degree to which cultural remains have survived natural and human-induced processes. In addition, European land-use practices often destroy or disturb artefacts from their original location and condition.

The extent of vegetation and the nature of erosion and deposition regimes also affect the visibility of cultural remains and hence the chances of their detection during ground surveys. Likewise, non-indigenous land-use practices can disturb artefacts from their original context of deposition.

There are seven CHMPs that apply to the Mainland GTP RoW. These plans have been negotiated with relevant Aboriginal Endorsed Parties under the requirements of the *Aboriginal Cultural Heritage Act (2003)* (ACHA). The CHMPs have been approved under Part 7 of the ACHA. Cultural heritage surveys, either completed or currently underway, are defining areas and sites of cultural significance that occur within the project area.

Each of the seven CHMPs in place for the Mainland GTP RoW include detailed provisions to deal with the management of impacts to Aboriginal cultural heritage sites. In accordance with the agreements with the Aboriginal parties, the survey findings will remain confidential and will not be disclosed to the public. Rather, findings will be subject to the management and mitigation measures set out in the CHMPs.

Table 12.3 provides an overview of the status of surveys with each group. The survey methodology generally involves an initial survey of a large (100-150 m) corridor along the proposed Mainland GTP RoW. Based on these findings, a second phase of fieldwork is undertaken, focusing on a 40 m construction corridor for full cultural heritage clearance. The second phase of fieldwork focuses on relocating/salvaging artefacts within the construction corridor and may also include archaeological investigations aimed at identifying and avoiding sensitive areas. At the conclusion of the second phase of fieldwork, a report is produced which details all findings and cultural heritage management requirements.

Table 12.3 Status of Aboriginal cultural heritage surveys proposed for the Mainland GTP RoW

Pipeline Survey Group	Introduction Meeting	Kick off meeting	Phase 1 fieldwork	Phase 2 Fieldwork	Report Finalised	Comment
Bidjara	11/12/09	17/03/10	18/03/2010 - 23/03/2010	<i>Commenced</i>	<i>To be finalised on completion of fieldwork</i>	GLNG OPL actioning route changes arising from initial findings in advance of final fieldwork (excavations and mitigation)
Bidjara overlap	11/12/09	17/03/10	29/03/2010 - 7/04/2010			
Iman	9/10/09	2/11/09	3/11/2009 - 10/11/2009	14/6/10 - 21/6/2010	10/12/10	Survey and reporting complete
Karingbal (Gap A)	7/10/09	24/11/09	25/11/2009 - 16/12/2009	<i>Commenced</i>	<i>To be finalised on completion of fieldwork</i>	GLNG OPL actioning route changes arising from initial findings in advance of final fieldwork (excavations and mitigation)
Karingbal (overlap)	7/10/09	24/11/09	20/01/2010 - 25/01/2010			
Gap B	25/09/09	Infield	28/09/2009 - 29/10/2009 13/11/2009 - 19/11/2009	23/10/2010 - 26/10/2010	17/12/10	Survey and reporting complete
Gangulu	9/02/10	16/08/10	20/10/10	<i>Scheduled to commence when surface visibility improves</i>	<i>To be finalised on completion of fieldwork</i>	Cultural Heritage Constraints report has been developed based on field visits and Gangulu's existing knowledge of project area
Port Curtis Coral Coast (Aboriginal) Corporation (PCCC)	N/A	30/11/10	2/12/10 – 22/12/10	<i>Commenced</i>	<i>To be finalised on completion of fieldwork</i>	The CIC Survey is substantially complete. Short Curtis Island section pending

Overall, progress has been delayed due to unseasonal weather restricting access and surface visibility. Cultural heritage surveys have been completed for substantial sections of the Mainland GTP RoW. This survey work includes a report on the findings of the survey and also identifies management recommendations to be implemented.

Identified sites

Consistent with the expectations set out in the EIS (URS 2009), there have been numerous Aboriginal cultural heritage sites identified along the Mainland GTP RoW. The most common site types have been:

- Stone artefacts, as isolates and in scatters, particularly in association with creeks and rivers
- Open camp sites, also in association with creeks or rivers
- Scarred trees in areas of remnant vegetation

One art site has been identified in the vicinity of the Mainland GTP RoW but outside of the project area. No burials or human remains have been located during the surveys. Registered sites located within the vicinity of the Mainland GTP RoW are shown in Figure 12.1.

12.2.2 Non Indigenous

The geographical area covered by the Mainland GTP RoW includes a diverse landscape stretching from the coastal area of Gladstone, inland to the CSG fields near Fairview. The history of the area encompasses maritime and inland exploration, pastoralism and conflict with Indigenous occupants, a long period of gradual 'opening up' of the land and the development of towns and infrastructure. Key industries such as cattle and mining have had a profound impact on the history of the region.

Identified sites

Table 12.4 below provides details of heritage/archaeological sites located within a 5km corridor either side of the Mainland GTP RoW. None of these sites are located within the Mainland GTP RoW itself, with their locations illustrated in Figure 12.2.

Table 12.4 Heritage sites within the Mainland GTP RoW project area

Site Type & HAS No.	Site Name	Registered	Site Significance	Justification (of significance assessment)
<i>Archaeological Site</i>				
HAS-09	Former Dudarcho Homestead	-	State	Remnant features illustrate period of sheep holdings attempted and later abandoned (failed) in QLD's history- potential contribution to understanding the evolution of land use across Queensland
HAS-20	Bonnie Doon Homestead	-	State	Potential to reveal development of isolated homesteads over extended periods of time within the region

Site Type & HAS No.	Site Name	Registered	Site Significance	Justification (of significance assessment)
<i>Heritage Site</i>				
HAS-05	Hazel Dean Homestead	-	State	<p>Criterion (a) - gateway to the region including terminus of the evidence of multiple development phase indicating evolution from dairying to pastoral concern. Illustrates pattern of early European settlement where development of pastoral properties preceded agriculture and town establishment</p> <p>Criterion (d) - demonstrates principle characteristics of a 1890s homestead</p> <p>Criterion (g) - association with the life and work of six generations of the Farmer family and early dairying in the area. Important role in the social network of the local area hosting community dances 1898-1950s</p>
HAS-22	Survey Tree	-	Local	<p>Criterion (a) - Provides evidence of surveying associated with the Burnett Highway construction</p> <p>Criterion (d) - representative of the method of marking routes, locations and settlement sites</p>
HAS-24	Old Dawson Highway Alignment	-	Local	<p>Criterion (a) - Provides contrast of modern infrastructure and evidence of early road transport conditions and networks in the Bauhinia Shire</p> <p>Criterion (c) - record of early road infrastructure and includes elements informing of the surveying, construction and associated telecommunications</p>
HAS-25	Camping Reserve	-	Local	<p>Criterion (a) - camping venue for travellers in transport corridor from Bauhinia to Rolleston</p> <p>Criterion (c) - potential records associated with transient occupation during 20th century</p>
HAS-31	Wooden Road Bridge	-	Local	<p>Criterion (a) - illustrates development of transportation around Moura and contrasts modern infrastructure</p> <p>Criterion (b) - one of few remaining wooden road bridges</p>
HAS-41	Kilbirnie Homestead	✓	State	<p>Criterion (a) - Kilbirnie homestead illustrates the pattern of early European exploration and settlement of Queensland where the development of pastoral properties preceded agriculture and the establishment of towns. As an early homestead in the Leichhardt Pastoral District, which has remained in use, it has associations with the development of the pastoral industry in Queensland.</p>

Site Type & HAS No.	Site Name	Registered	Site Significance	Justification (of significance assessment)
				<p>(d) Kilbirnie homestead complex provides a record of an evolving pastoral property from the slab buildings of first settlement in the 1880s to a comfortable house of sawn timber. It demonstrates the principal characteristics of such a homestead group well, comprising a main house with detached kitchen, associated outbuildings, graves and fences and illustrates the building techniques traditionally used for these</p> <p>(h) Kilbirnie homestead has a special association with the life and work of four generations of the Campbell family who, as early pastoralists, contributed to the development of the area</p>

Table note HAS- Heritage and Archaeological Site

Source Aboriginal and Torres Strait Islander Cultural Heritage Database and Register Queensland Heritage Register (QHR)

12.3 Potential adverse or beneficial impacts on existing cultural heritage values (construction and operation)

12.3.1 Indigenous

Management of impacts to each site has been agreed on a case-by-case basis with each group. Management actions are classified in three categories: pre construction, construction and post construction.

Pre construction

In most cases, artefacts that are to be impacted by construction of the Mainland GTP RoW will be relocated with the consent of the relevant Aboriginal group. In areas of high cultural heritage sensitivity, management options have included a restricted construction RoW or re-alignment of the proposed route to avoid the area. Some sites in close proximity to the construction area, or sites of high significance in the general proximity of the Project, including the Mainland GTP RoW, will be fenced and signed before construction commences.

Construction and post construction

During construction, there will be monitoring of earthworks by group representatives in areas of high heritage sensitivity or where sub-surface archaeological deposits are likely. Compliance audits during and after construction will also be undertaken as per the CHMPs. Representatives from each cultural heritage group will be given an opportunity to provide cultural heritage awareness inductions to GLNG Operations and Contractor personnel prior to construction.

In the event that cultural heritage items are identified during construction, the following actions as proposed in each of the CHMP's will be undertaken:

- Immediately cease any work that may disturb the site or artefact.
- Do not touch or interfere with the possible site or artefact
- Notify Supervisor and a representative from the Cultural Heritage Team
- Fill out the 'Discovery of Cultural Heritage Form' and submit



Mainland GTP EM Plan

- Gas Transmission Pipeline (GTP)
 - Mainland GTP EM Plan
 - Marine Crossing GTP EM Plan
 - Curtis Island GTP EM Plan
- Kilometre Post Distance Marker
 - 50km
 - 10km
- Indigenous Site
- Cadastral
- Rail
- Watercourse
- Major Road

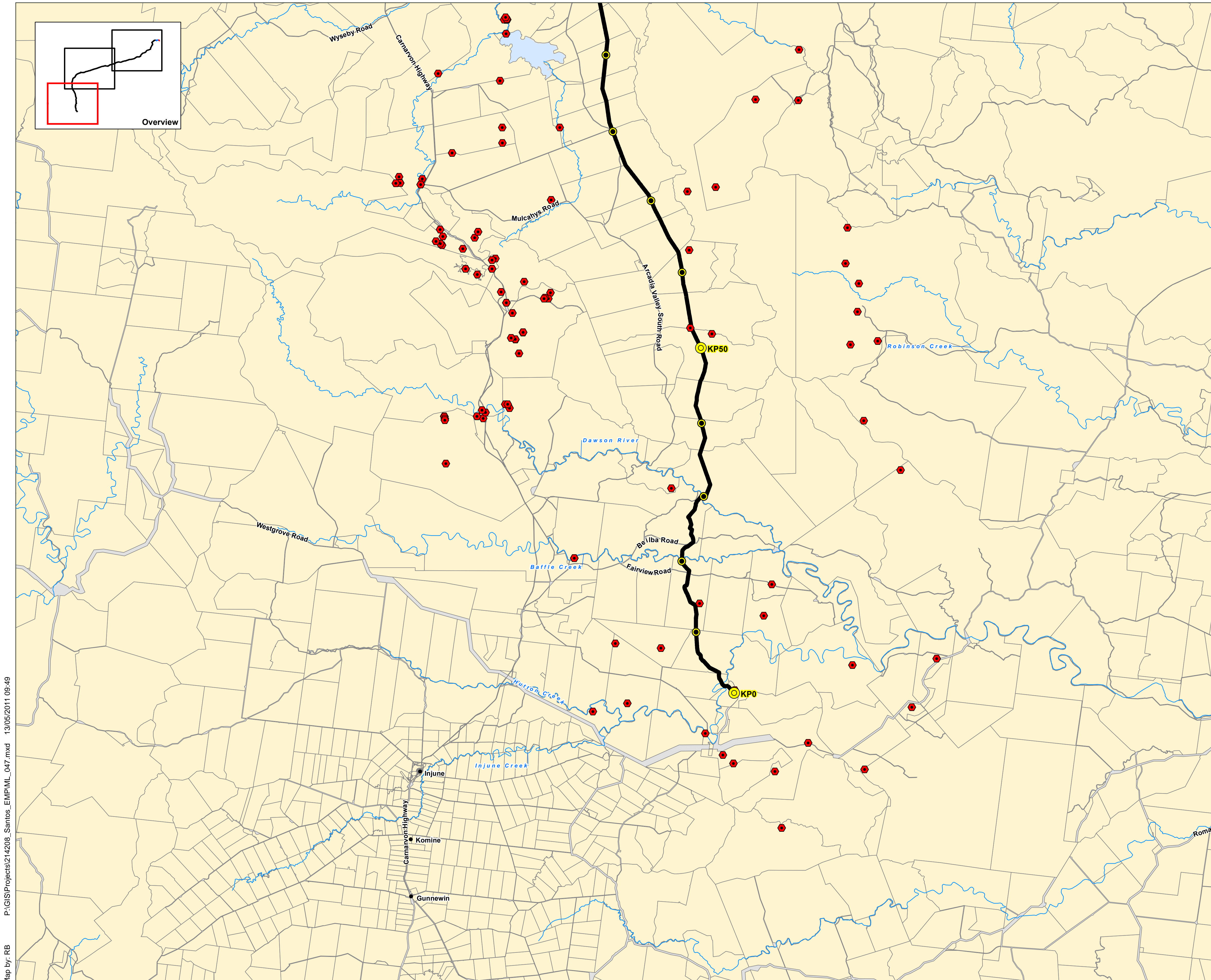
Source:
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 Cadastral: Department of Environment and Resource Management, Jun 2011.
 Cultural Heritage Sites: Department of Environment and Resource Management, May 2011.

Indigenous Cultural Heritage Sites

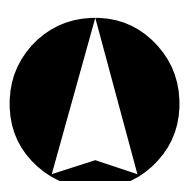
Figure 12.1 (Page 1 of 3)

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GLNG No: 3381-40-0535
 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

- Gas Transmission Pipeline (GTP)
 - Mainland GTP EM Plan
 - Marine Crossing GTP EM Plan
 - Curtis Island GTP EM Plan
- Kilometre Post Distance Marker
 - 50km
 - 10km
- Indigenous Site
- Cadastral
- Rail
- Watercourse
- Major Road

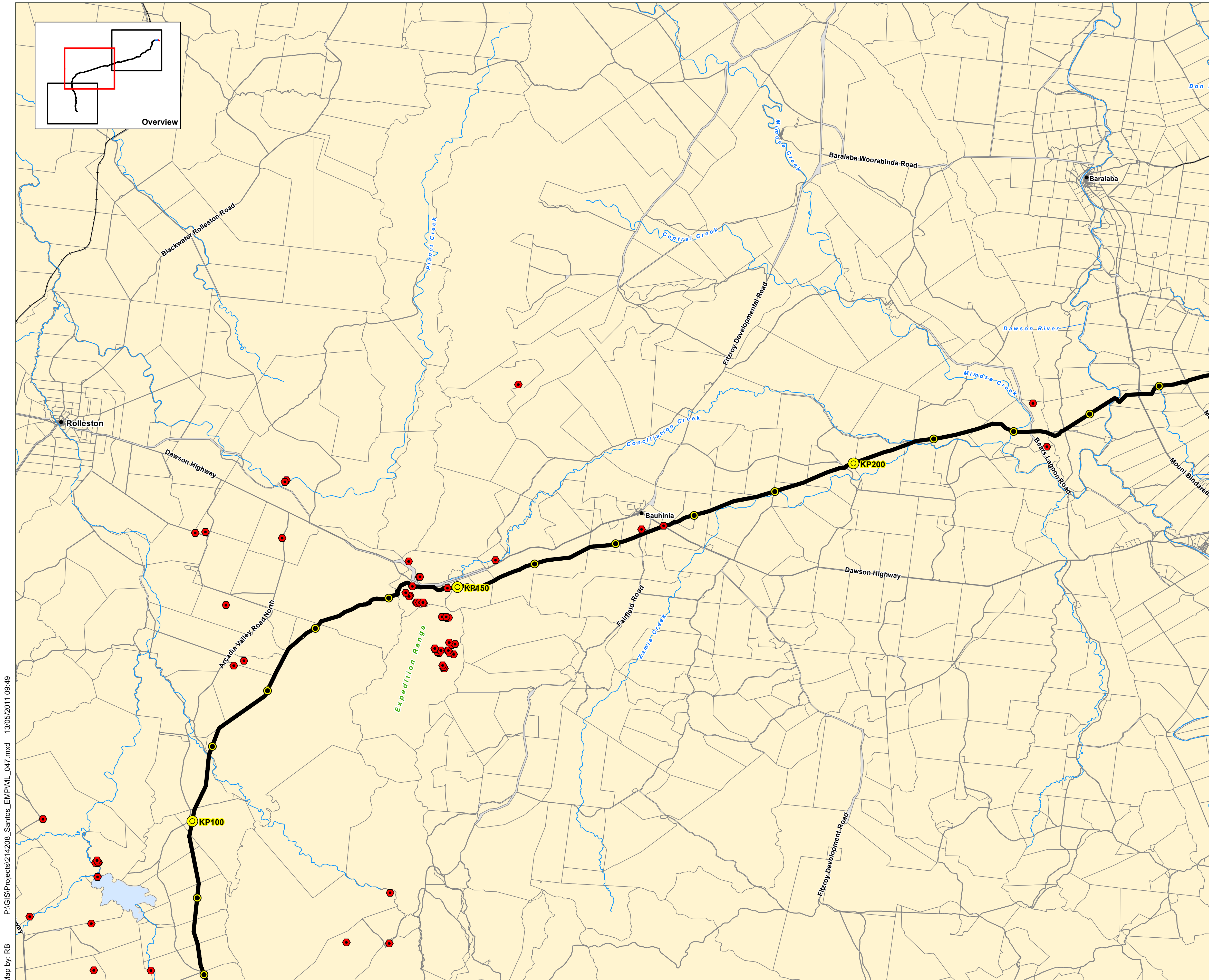
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 Cultural Heritage Sites: Department of Environment and Resource Management, May 2011.

Indigenous Cultural Heritage Sites

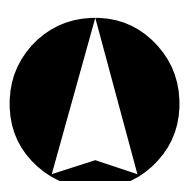
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Mainland GTP EM Plan

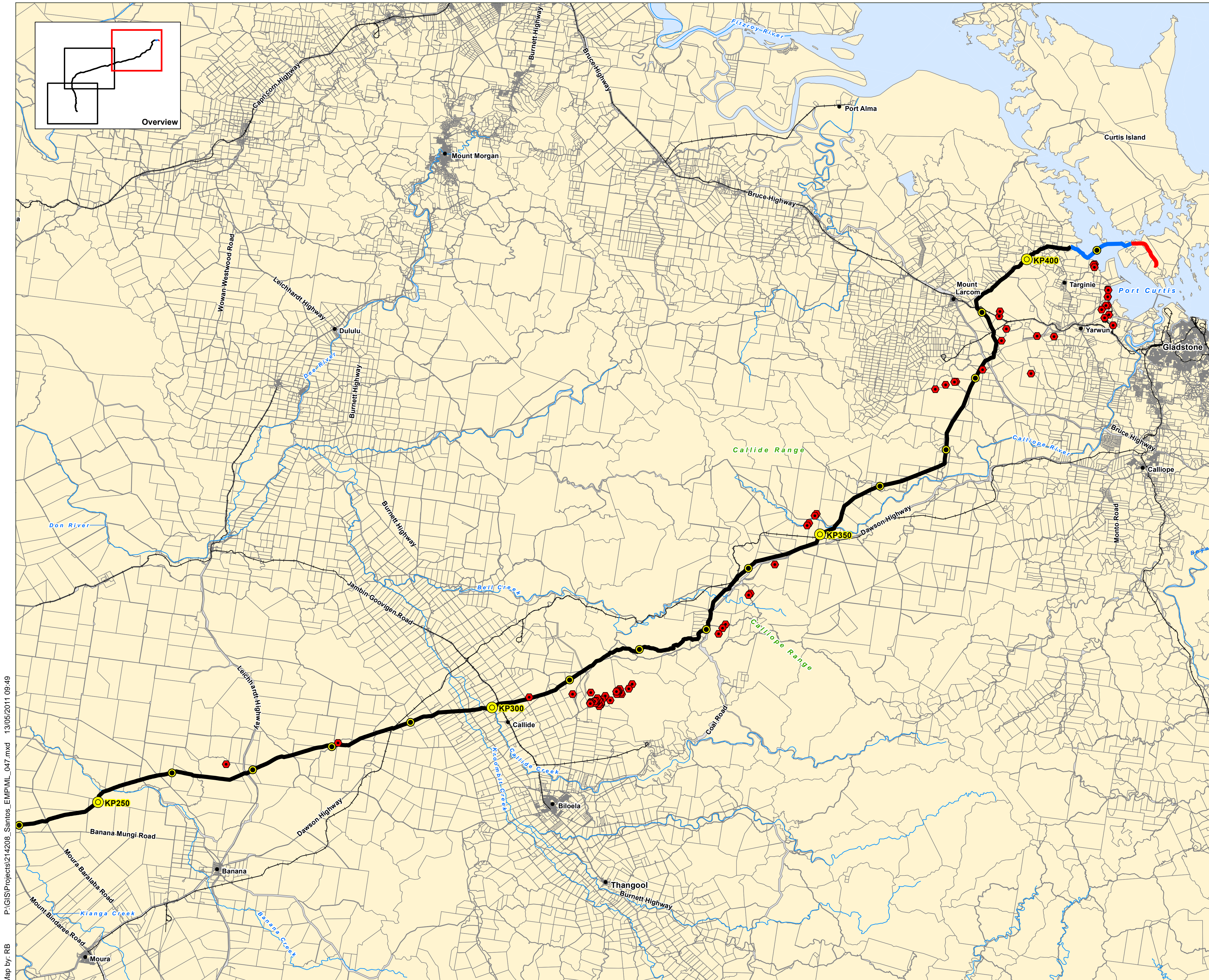
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 Cultural Heritage Sites: Department of Environment and Resource Management, May 2011.

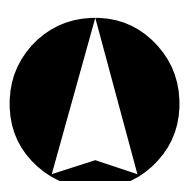
Indigenous Cultural Heritage Sites Figure 12.1 (Page 3 of 3)

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Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 50km
- 10km

Assessed Sites by GLNG Project

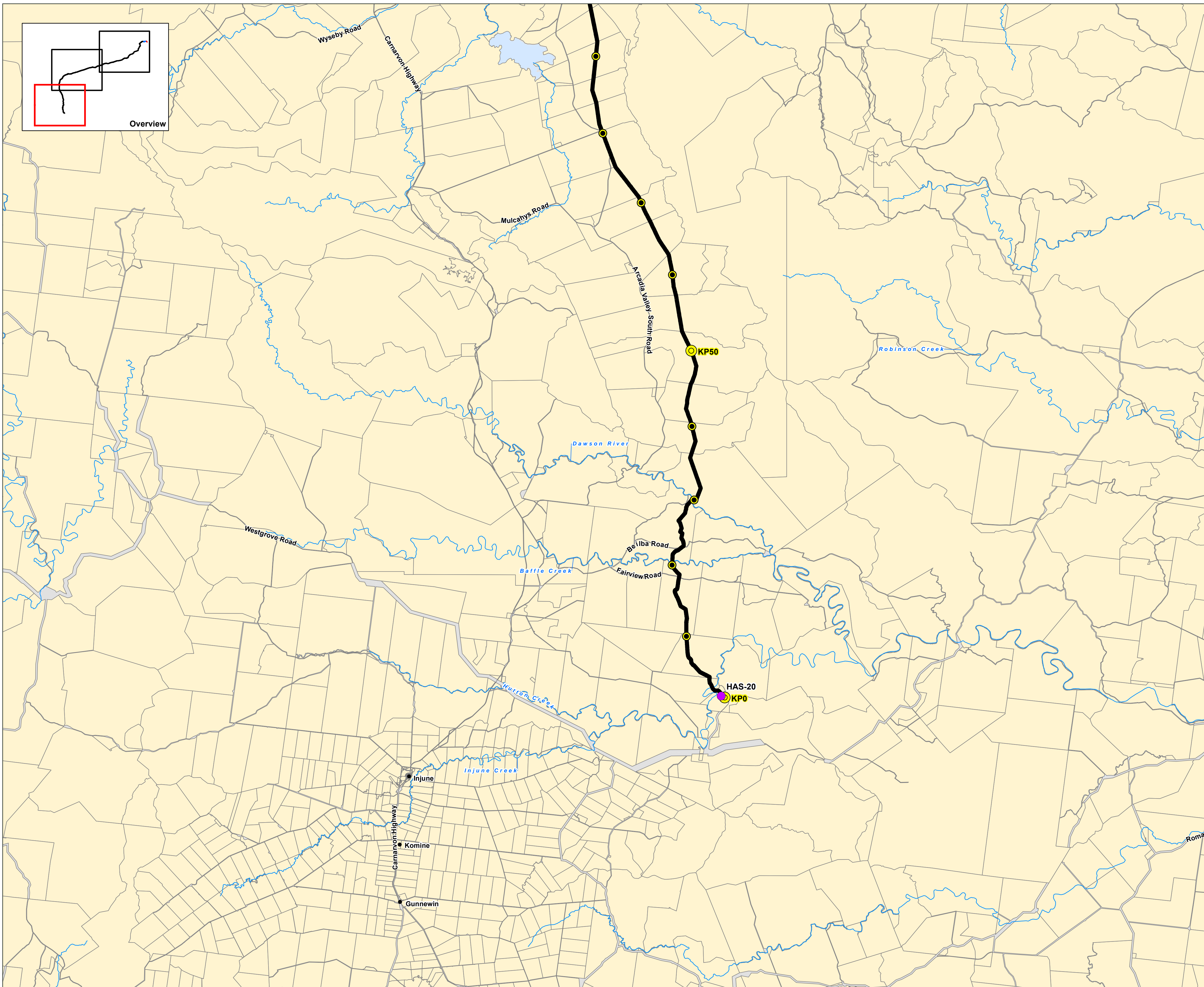
- Assessed Precincts by GLNG Project
- Registered Sites

Cadastre

Rail

Watercourse

Major Road



Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Cadastre: Department of Environment and Resource Management, Jun 2011.
 Cultural Heritage Sites: GLNG EIS, 2009.

Note: Locations of Cultural Heritage Sites are indicative only.

Non Indigenous Cultural Heritage Sites

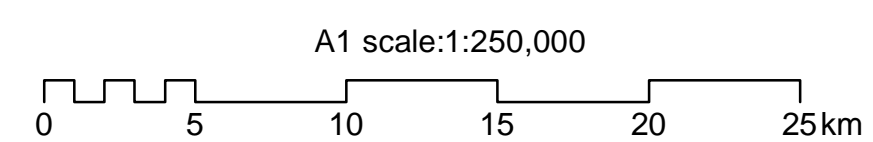
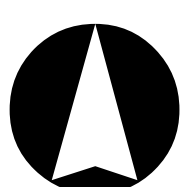
Figure 12.2 (Page 1 of 3)

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Map by: RB



GLNG No: 3381-40-0536
 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 50km
- 10km

Assessed Sites by GLNG Project

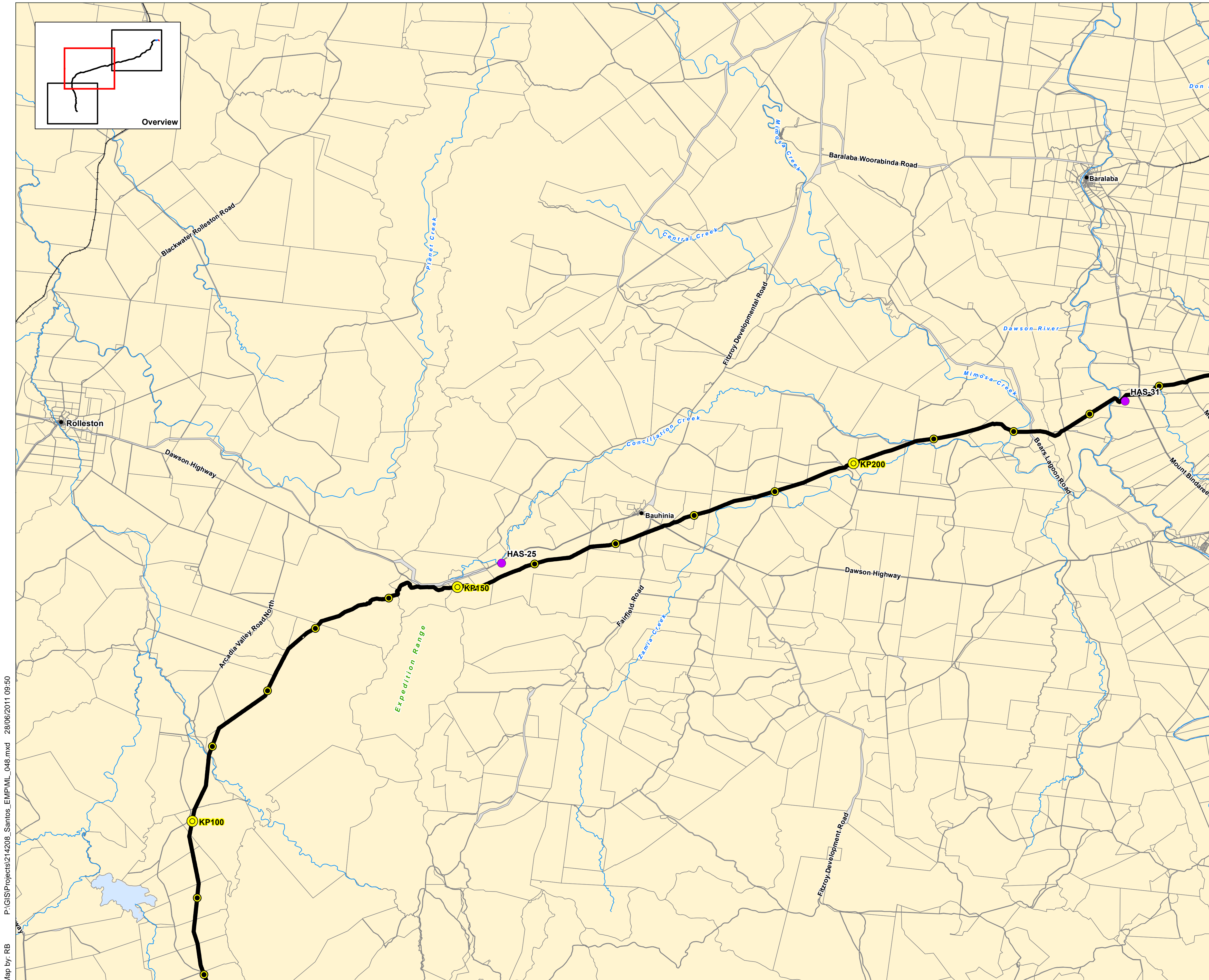
- Assessed Precincts by GLNG Project
- Registered Sites

Cadastre

Rail

Watercourse

Major Road



Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Cadastre: Department of Environment and Resource Management, Jun 2011.
 Cultural Heritage Sites: GLNG EIS, 2009.

Note: Locations of Cultural Heritage Sites are indicative only.

Non Indigenous Cultural Heritage Sites

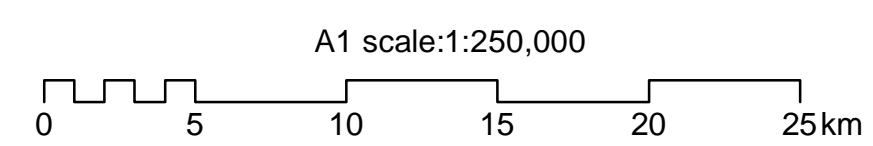
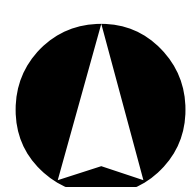
Figure 12.2 (Page 2 of 3)

Date: 28/06/2011

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Map by: RB



GLNG No: 3381-40-0536
 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 50km
- 10km

Assessed Sites by GLNG Project

Assessed Precincts by GLNG Project

Registered Sites

Cadastral

Rail

Watercourse

Major Road



Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Cadastral: Department of Environment and Resource Management, Jun 2011.
 Cultural Heritage Sites: GLNG EIS, 2009.

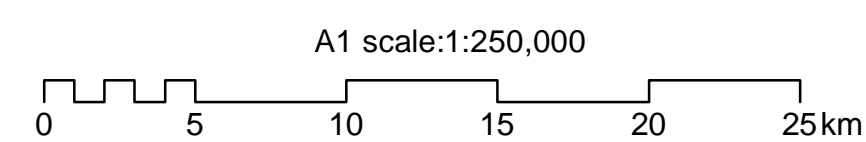
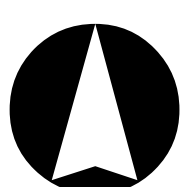
Note: Locations of Cultural Heritage Sites are indicative only.

Non Indigenous Cultural Heritage Sites Figure 12.2 (Page 3 of 3)

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Map by: RB



A1 scale: 1:250,000

GLNG No: 3381-40-0536
Coordinate system: GCS GDA 1994

- A buffer zone of 50 m to be established around the site. Works may not commence in the buffer zone until the Cultural Heritage Team has provided an approval to do so.
- Works may proceed outside of the 50 m buffer zone

Proposed construction camps are not located in any areas identified as being registered Indigenous cultural heritage sites. During construction of the camps, where any cultural heritage items are identified, the management measures as identified above will be implemented.

12.3.2 Non Indigenous

There are several areas, where the Mainland GTP RoW encounters or comes close to sites of cultural heritage significance: eg Heritage and Archaeological Site (HAS)-05, HAS-09, HAS-20, HAS-22, HAS-24, HAS-25, HAS-31 and HAS-42 and HI-05 and HI07. HAS-41 is the Kilbirnie Homestead site which is listed on the Queensland Heritage Register. The proposed alignment traverses in close proximity to the site boundary, although is 2.1 km from the Homestead complex (see Figure 12.3).

Infrastructure within the Mainland GTP RoW will be located to avoid known non-indigenous sites. In the event that a site is identified during construction it shall be demarcated and access restricted where construction works are close to the heritage site.

Any impact to other sites of local significance will be minimised unless absolutely essential. In the case that a site of local significance will be impacted, archival recording by a qualified specialist will be undertaken in accordance with international standards.

The preferred route for the Mainland GTP RoW is the best option amongst the routes considered by GLNG Operations for the preservation of non indigenous cultural heritage.

DERM will be notified of the discovery of any archaeological artefact.

Proposed construction camps are not located in any areas identified as being registered Heritage or Archaeological sites. During construction of the camps, works will be undertaken as per the management measures outlined in Table 12.5 so as to minimise any potential adverse impacts.

12.3.3 Operational impacts

Operational activities will typically include monthly inspections along the Mainland GTP RoW by vehicle and foot patrols to check on the condition of the GTP and associated infrastructure. Maintenance will be carried out by light vehicles and small maintenance crews on an annual basis, or as and when required. Cultural heritage (indigenous and non indigenous) related impacts from these operational activities will be managed in accordance with the relevant CHMP and OMP, which will be developed and implemented prior to the completion of the construction phase.

DERM will be notified of the discovery of any archaeological artefact.

12.4 Cumulative impacts

Cumulative cultural heritage impacts are described below. This cumulative impact assessment is based on the impact scope, identification and scoring methodology described in Chapter 2 of this EM Plan.

There are areas of cultural heritage significance that have been identified within the CICSDA and GSDA Corridors. Further sites of cultural heritage may be discovered within the designated corridors.

12.4.1 Indigenous cultural heritage (disturbance to archaeological remains)

There are a number of registered Indigenous cultural heritage sites within the CICSDA and GSDA Corridors. Higher concentrations of heritage sites are located around the Callide Range, particularly near the Callide Timber Reserve, along the Calliope River, around Mount Larcom Range and towards the Port of Gladstone.

These sites of indigenous cultural heritage include:

- Artefacts, scatters and camp sites near creeks and rivers
- Scarred trees in remnant vegetation
- Art sites, burials and rock shelters in the ranges

These may be exposed to cumulative impacts from disturbance from multiple proponents in the area. For example, if cultural heritage sites are identified on clearing of vegetation or disturbance of topsoil, these may consist of scatters of material that could extend across construction footprints of some or all of the proponents.

Potential additional mitigation measures that will be considered during the preconstruction and construction phases of the Project are:

- Where possible and with the agreement of the Traditional Owners involved, share information with other proponents if any areas or artefacts of indigenous cultural heritage areas are found during construction in the CICSDA or GSDA corridors

There will be minor negative cumulative impacts on indigenous cultural heritage (disturbance to archaeological remains).

12.4.2 Non indigenous cultural heritage

Known areas of non-indigenous cultural heritage have been identified in the pipeline corridors.

Of particular interest is the Kilbirnie Homestead site, which is listed on the National Trust Register and Queensland Heritage Register. This site is located near Callide, west of the Callide Timber Reserve.

A number of unlisted sites are located along the CICSDA and GSDA corridors, including:

- Dudarcho homestead
- Stone pitching area
- The Mole Hill
- Mount Alma homestead
- Hazeldean graves
- Kaluda Park boiler
- Mount Larcom yards
- Mount Larcom Station graves
- Shepherd's hut
- Mount Larcom homestead
- Survey tree.

Sites close to the CICSDA and GSDA Corridors may experience increased activity due to the number of proponents active in the area, however, this impact is not expected to be negative and will inevitably be managed in each proponents EM Plans.

Pipeline routes have been selected to avoid areas of non-indigenous cultural heritage significance; however, greater area of disturbance may lead to new discoveries or sites that will need to be managed in accordance with this EM Plan.

Cumulative impacts to non-indigenous cultural heritage are anticipated be minor.

Potential additional mitigation measures that will be considered during the preconstruction and construction phases of the Project are

- To share information with other proponents if any areas of non-indigenous cultural heritage areas are found during construction in the CICSDA or GSDA corridors

12.5 Environmental protection commitments, objectives and control strategies – Cultural heritage (construction and operation)

Table 12.5 Proposed mitigation measures for the management of cultural heritage

Item	Detail
Environmental protection objective	<ul style="list-style-type: none"> • To protect the cultural heritage values of the GTP RoW
Specific objectives	<ul style="list-style-type: none"> • Compliance with the requirements of the <i>Aboriginal Cultural Heritage Act 2003</i> and the relevant Cultural Heritage Management Plans (CHMPs) • No disturbance of any place on the Queensland Heritage Register in accordance with the requirements of the <i>Queensland Heritage Act 1992</i>
Control strategies	<p>Preconstruction phase</p> <ul style="list-style-type: none"> • GLNG Operations will develop and implement CHMPs in consultation with the relevant Aboriginal Parties. Protection, management and mitigation measures will be agreed after cultural heritage surveys are complete, and will be incorporated in GLNG Operations cultural heritage management system • GLNG Operations will seek to gain relevant native title permissions for the pipeline via the negotiation and registration of Indigenous Land Use Agreements (ILUAs) or the grant of Ministerial permissions under the <i>Petroleum and Gas (Production and Safety) Act 2004</i> where ILUAs are not achievable • Infrastructure will be located to avoid known cultural heritage sites. All heritage sites shall be demarcated and access restricted where construction works are close to the heritage site • Where potential non-indigenous heritage material is identified and likely to be disturbed, GLNG Operations will determine the significance of the site in consultation with the DERM and undertake relocation / preservation of the material. A project specific conservation management plan will be prepared to establish mitigation, management and approval procedures • Include cultural heritage issues in the project induction program and involve representatives from the Aboriginal Parties in the development and implementation of such programs • Specific mitigation measures will be developed to minimise any impact on the Kilbirnie Homestead site in consultation with relevant stakeholders including the DERM • GLNG Operations will educate its staff and contractors on the location and significance of the heritage sites to avoid disturbance

Item	Detail
	<p>Construction phase</p> <ul style="list-style-type: none"> • Fencing and signage of sensitive areas/sites • In accordance with the CHMP's, development of a cultural heritage management compliance handbook for contractors, including procedures for site discoveries during construction. These will include details of: <ul style="list-style-type: none"> - An approved alignment and corridor for construction (25-40 m) - Specific details of all cultural heritage sites in the project area (100 – 150 m) that remain in-situ - Specific cultural heritage management requirements (avoidance or monitoring) by site and by location in relation to: <ul style="list-style-type: none"> - Cultural heritage sites - Culturally sensitive areas - Areas with potential for sub-surface cultural heritage - Other cultural heritage management requirements including site inductions and post-construction audits; - Procedures for previously unidentified sites located during construction; - A detailed description of roles, responsibilities and procedures associated with: <ul style="list-style-type: none"> - Day-to-day communication with each group - The delivery of site inductions - Planning, mobilisation and supervision of cultural heritage officers undertaking monitoring or audits - Any other aspects of engagement with the Aboriginal groups • GLNG Operations will seek to educate its staff and contractors on the location and significance of the sites to avoid disturbance • Training of field workers will be undertaken as part of broader environmental awareness training and/or Workplace Health and Safety meetings • Training materials will inform the workers as to what archaeological material and cultural heritage sites may look like and provide clear instructions on what to do if they find anything • During construction, there will be monitoring of earthworks by group representatives in areas of high heritage sensitivity or where sub-surface archaeological deposits are likely • Representatives from each cultural heritage group will be given an opportunity to provide cultural heritage awareness inductions to GLNG Operations and Contractor personnel prior to construction • If personnel discover what may be a cultural heritage, the following will be undertaken: <ul style="list-style-type: none"> - Immediately cease any work that may disturb the site or artefact - Do not touch or interfere with the possible site - Notify Supervisor and a representative from the Cultural Heritage Team - Fill out the 'Discovery of Cultural Heritage Form' and submit - A buffer zone of 50 m is established around the site. Works may not commence in the buffer zone until the Cultural Heritage Team has provided an approval to do so - Works may proceed outside of the 50 m buffer zone <p>Operational phase</p> <ul style="list-style-type: none"> • Typical mitigation and controls for the operational phase of the Project will be detailed in the Operational Management Plan, which will be developed prior to construction
<p>Performance indicators</p>	<ul style="list-style-type: none"> • Compliance with the requirements of the <i>Aboriginal Cultural Heritage Act 2003</i> and the relevant Cultural Heritage Management Plans (CHMPs) • No disturbance of any place on the Queensland Heritage Register in accordance with the requirements of the <i>Queensland Heritage Act 1992</i>

13. Waste management

13.1 Chapter summary

This chapter covers the waste management information and proposed arrangements which relate to construction, operation and decommissioning of the Mainland GTP section.

13.1.1 Summary of waste issues

- The Project will adopt the waste and resource management hierarchy principles for the optimal management of all wastes generated from the Mainland GTP
- The waste types and estimated quantities potentially to be generated from construction, operation and decommissioning activities are presented in Table 13.9 to Table 13.11
- The waste generation lists have been compiled relative to the following key activity areas:
 - Temporary Pipe Receiving Area at Gladstone Logistic Base
- Temporary Pipe Receiving Area at Port Alma
 - Mainland RoW including temporary pipe storage sites and RoW access points
 - Construction camps including vehicle and equipment workshops
- Proposed waste haulage routes, local waste disposal facilities and pipeline features are shown on Figure 13.2
- The rehabilitation of the GLNG RoW including the Mainland GTP section and associated infrastructure is not expected to generate large volumes of waste during the decommissioning phase

13.1.2 Summary of potential impacts related to waste management

Construction

Potential impacts may include water contamination, land contamination from spills, increased occurrences of vermin, impact on visual amenity, wasteful use of finite resources and adverse effects to flora and fauna. These impacts have been detailed in Table 13.8. It is considered that the potential impacts resulting from construction of the Mainland GTP section are expected to be acceptable and manageable as construction works will be undertaken in accordance with the control strategies as outlined in Section 13.10 and the Waste MP (Appendix F). Additionally, construction and operation activities will require the use of chemicals and hazardous materials and generate waste chemicals and hazardous materials. Chemical and hazardous materials associated with the GTP activities will be handled and stored in accordance with the applicable State or Commonwealth legislation.

Operation

It is considered that waste related impacts resulting from the operation of the Mainland GTP will be acceptable and manageable due to the low volumes of waste produced. Furthermore, operational activities will be undertaken in accordance with the Waste MP (Appendix F) and an Operational Management Plan (OMP) that will be developed and implemented prior to the completion of construction.

13.1.3 Summary of proposed mitigation measures for waste management

Table 13.1 Environmental protection commitments, objectives and control strategies for waste management

Item	Detail
Environmental protection objective	<ul style="list-style-type: none"> To ensure that the transmission pipeline construction adheres to the waste management hierarchy of avoid, reduce, re-use and recycle. Where this is not possible, to dispose of waste in the most appropriate manner To protect the quality of local land and water resources during pipeline hydrotesting To ensure that storage and handling of chemicals and dangerous goods does not cause environmental harm or harm to persons
Specific objectives/Performance criteria	<ul style="list-style-type: none"> No inappropriate disposal or management of waste No contamination of soil, air or water as a result of waste handling Petroleum activities do not result in the release or likely release of contaminants to the environment from the storage, conditioning, treatment and disposal of regulated waste materials Appropriate permits obtained prior to drawing water No existing water sources unsustainably depleted to provide hydrotesting water No adverse impacts on soil or surface water as the result of discharging hydrotesting water Petroleum activities do not result in the release or likely release of a hazardous contaminant to the environment Storage and handling procedures correct and appropriate Chemicals stored in secure areas All containment systems must be designed to minimise rainfall collection within the system
Control/Implementation strategies	Refer to Table 13.9, Table 13.10 and Table 13.11 for waste management control strategies to be implemented during construction, operation and decommissioning of the Mainland GTP
Performance indicators	<ul style="list-style-type: none"> Waste is being appropriately managed and disposed of Waste handling is not resulting in the contamination of soil, air or water Permits to draw water are in place Hydrotesting water is not unsustainably depleting existing water sources Discharge of hydrotesting water is not adversely impacting on soil or surface water The environment is not being contaminated by hazardous goods Correct and appropriate storage and handling procedures are in place Chemicals are stored in secure areas Collection of rainfall is minimised in all containment systems

13.2 Background

This chapter covers the waste management information and proposed arrangements which relate to construction, operation and decommissioning of the Mainland GTP RoW.

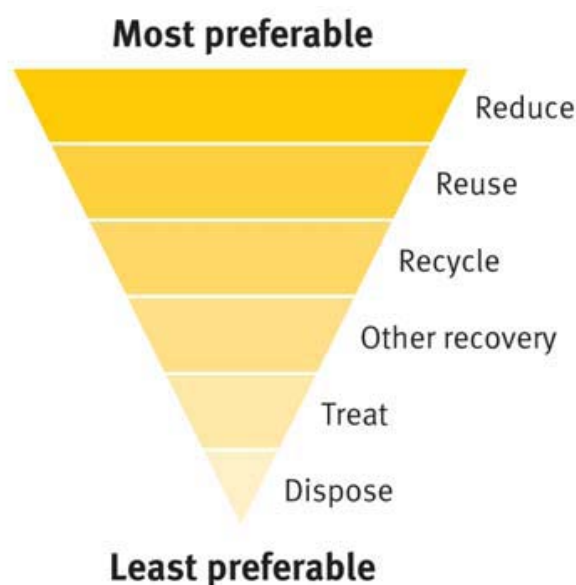
The waste management information has been developed in accordance with the *Environmental Protection Act 1994, Environmental Protection (Waste Management) Policy 2000* (EPP(Waste)) and CG Report. The chapter also considers other relevant State and Commonwealth legislation, guidelines and standards. This information has then been documented for the following key areas:

- The types and amounts of waste which are expected to be generated including general waste and recyclables, chemical and hazardous materials, liquid wastes and hydrotest waters
- Proposed environmental protection commitments, objectives and control strategies associated with Mainland GTP RoW wastes in accordance with the waste management hierarchy
- Any potential impact on the environmental values

The Waste Management Plan (Waste MP) (refer Appendix F) provides details on the management of waste for the entire GTP ('the Project') which encompasses Mainland, Marine Crossing and Curtis Island sections.

13.3 Waste and resource management hierarchy

The management of all waste and surplus material, resulting from activities of the Mainland GTP construction and operation, will be in accordance with the principles of the waste and resource management hierarchy¹ (Figure 13.1) as described in the Queensland Waste Reduction and Recycling Strategy 2010 - 2020. The waste and resource management hierarchy depicts disposal as the least desired option for managing waste. The most desired options of reduction, reuse and recycling are located at the top of the hierarchy.



Source Queensland's Waste Reduction and Recycling Strategy 2010–2020 DERM

Figure 13.1 Waste and resource management hierarchy

¹ Prior to publishing of the Queensland Waste Reduction and Recycling Strategy 2010 – 2020, the Waste and resource management hierarchy was referred to in Queensland Legislation and other government documents as the Waste Management Hierarchy comprising waste avoidance, waste reuse, waste recycling, energy recovery and waste disposal



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 50km
- 10km

Road Haulage Route

- Waste to Landfill; regulated waste and recyclables via approved route to SE Qld
- Other GLNG haulage route

- Port Alma Temporary Pipe Receiving Area
- Landfill
- Sewage Treatment Plant
- Temporary Pipe Storage Site
- Construction Camp
- Vehicle Washdown and RoW Access Point (Indicative Location Only)

Barge Haulage Route

- Cadastre
- Rail
- Watercourse
- Major Road

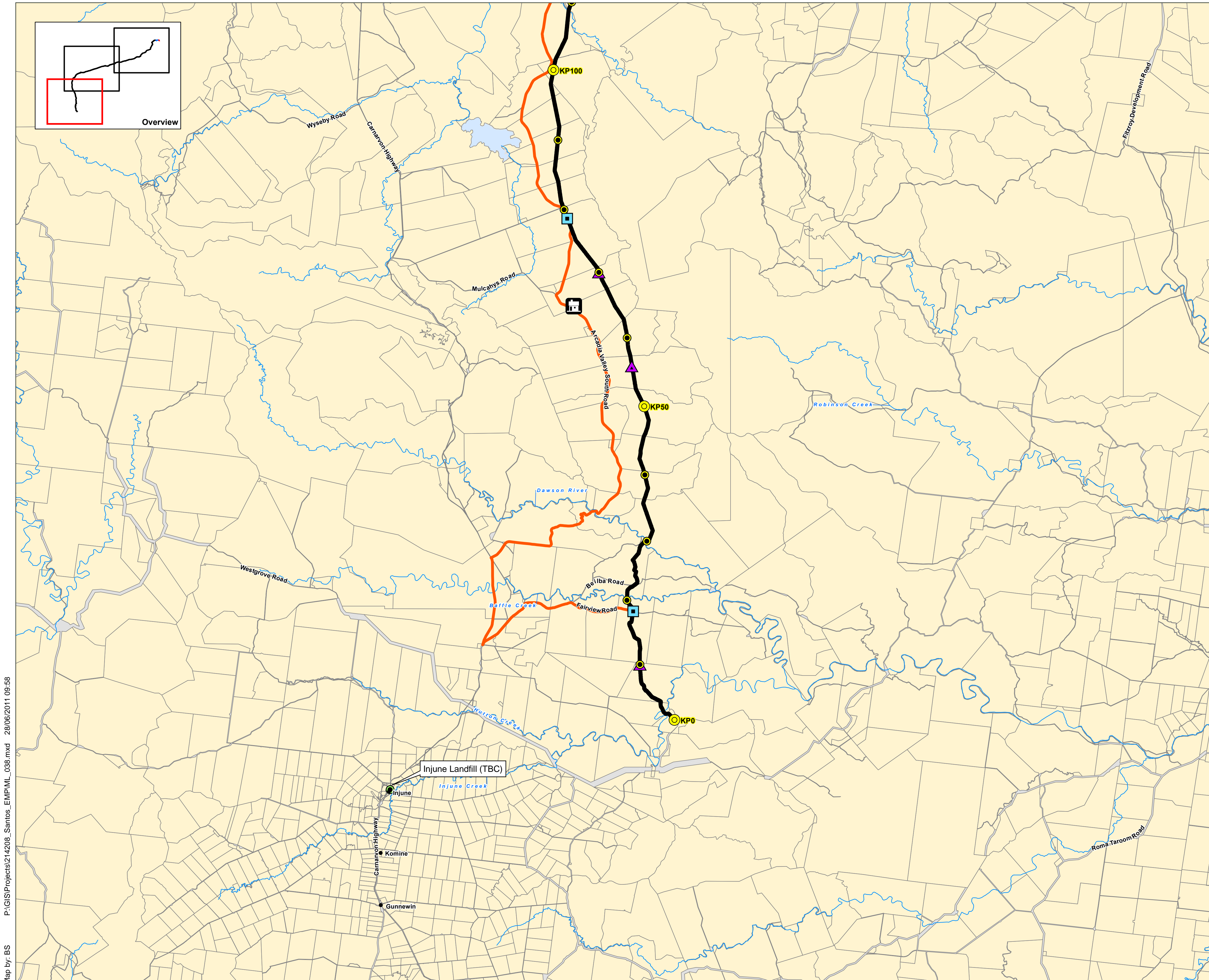
Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Fishermans Landing and Western Basin Reclamation Area, Aurecon, Feb 2011.
 Protected Areas: Department of Environment and Resource Management, Feb 2011.
 Cadastre: Department of Environment and Resource Management, Jun 2011.
 Temporary Pipe Storage Site: GLNG Pipeline Logistics Study, GHD, Nov 2009.
 Vehicle Washdown Points: Aurecon, Feb 2011.
 Construction Camps: GLNG Pipeline Logistics Study, GHD, Nov 2009.

Waste and Recovered Material Haulage Route

Figure 13.1 (Page 1 of 3)

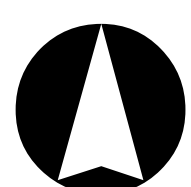
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Map by: BS



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GLNG No: 3381-40-0425
 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

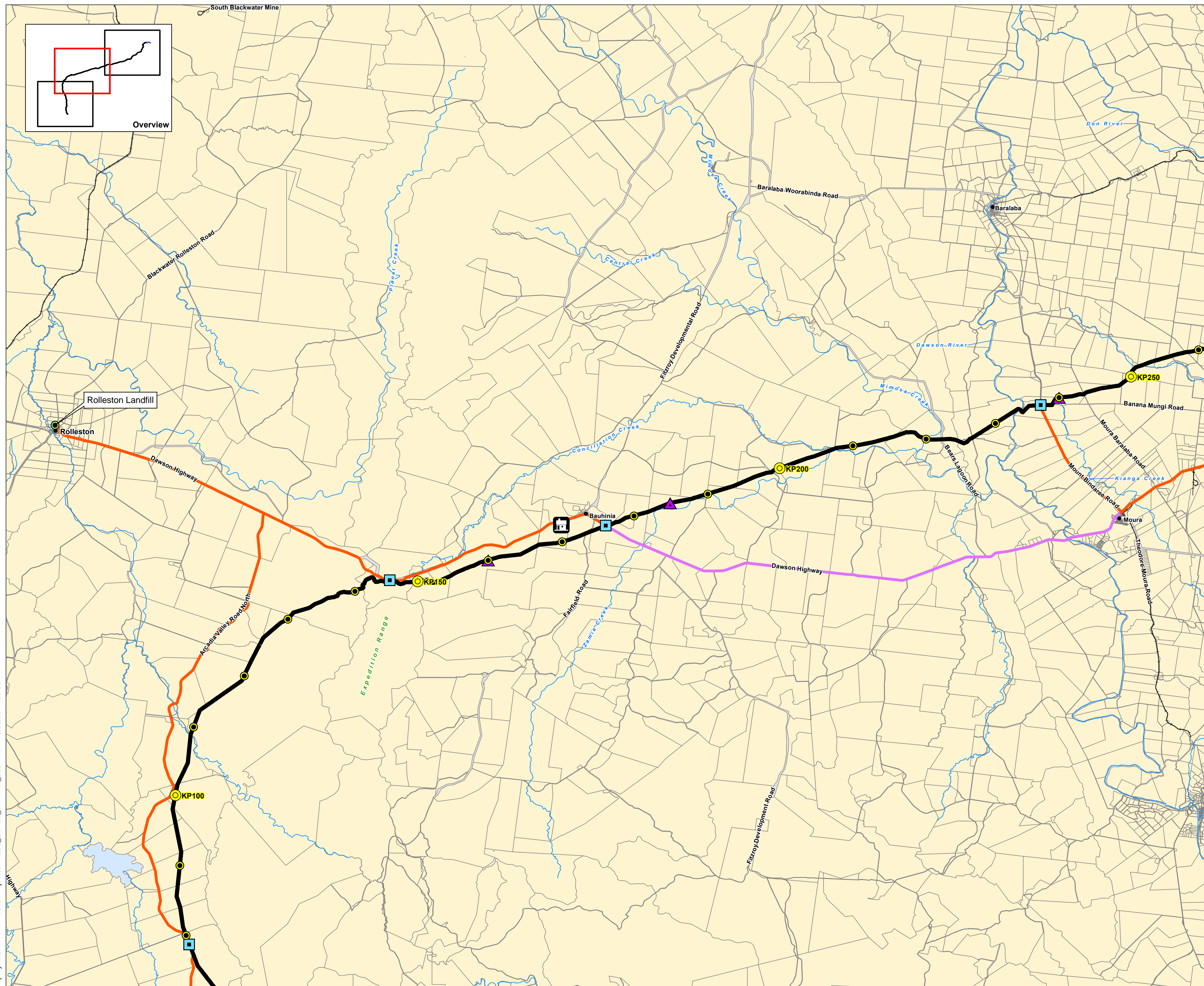
- Gas Transmission Pipeline (GTP)
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- Kilometre Post Distance Marker
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- Road Haulage Route
 - Waste to Landfill; regulated waste and recyclables via approved route to SE Qld
 - Other GLNG haulage route
- Port Alma Temporary Pipe Receiving Area
 - Landfill
 - Sewage Treatment Plant
 - Temporary Pipe Storage Site
 - Construction Camp
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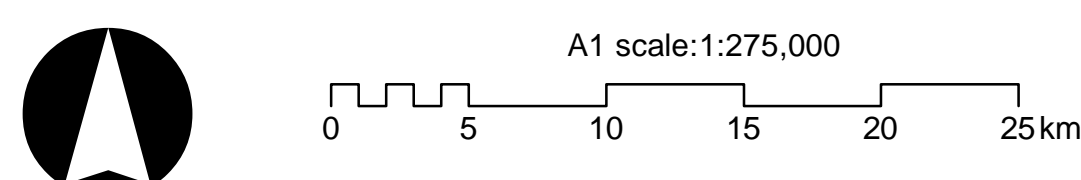
Waste and Recovered Material Haulage Route
Figure 13.1 (Page 2 of 3)

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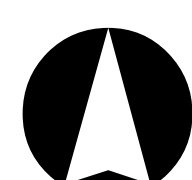
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GLNG No: 3381-40-0425
 Coordinate system: GCS GDA 1994





Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 50km
- 10km

Road Haulage Route

- Waste to Landfill; regulated waste and recyclables via approved route to SE Qld
- Other GLNG haulage route

- Port Alma Temporary Pipe Receiving Area
- Landfill
- Sewage Treatment Plant
- Temporary Pipe Storage Site
- Construction Camp
- Vehicle Washdown and RoW Access Point (Indicative Location Only)

Barge Haulage Route

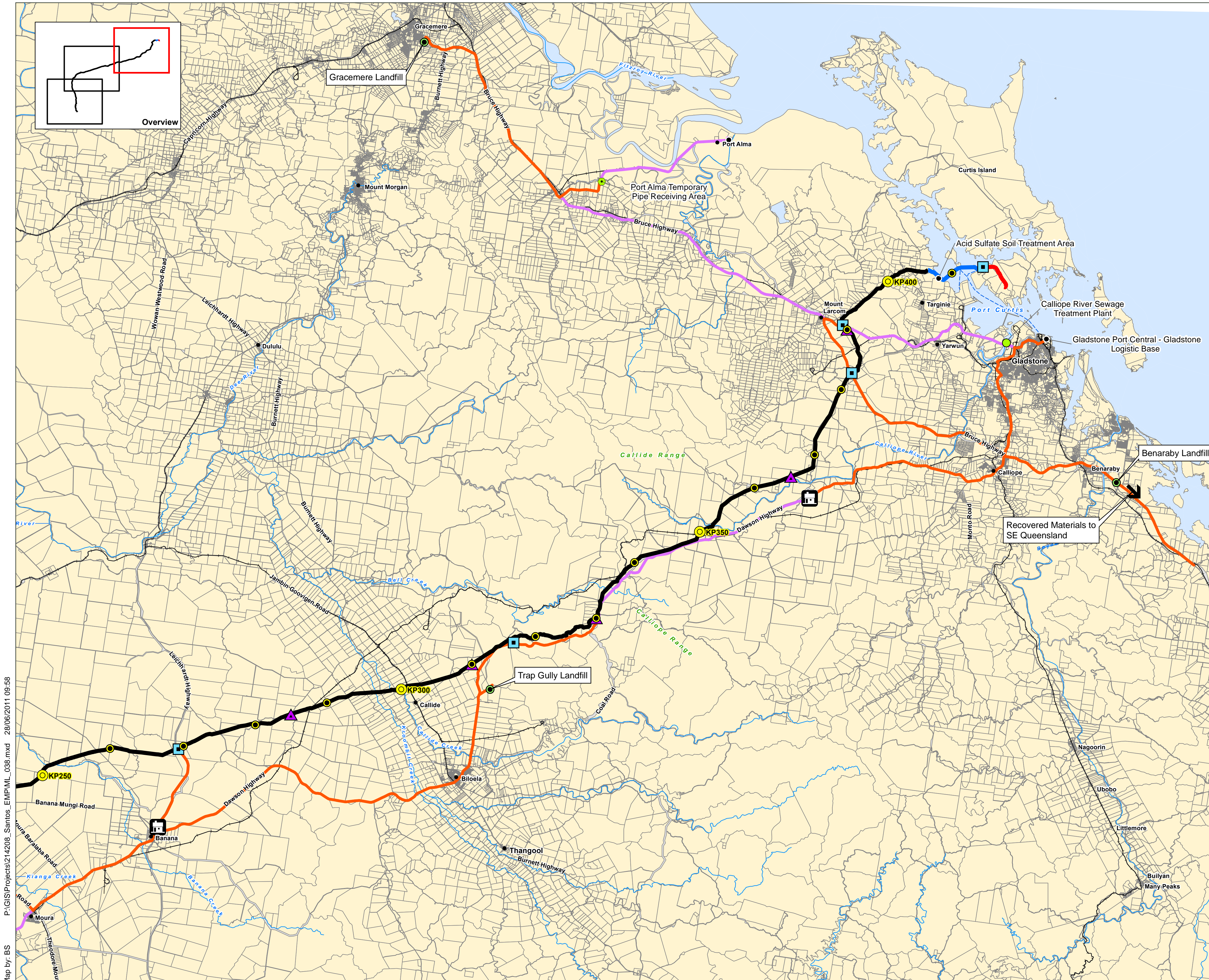
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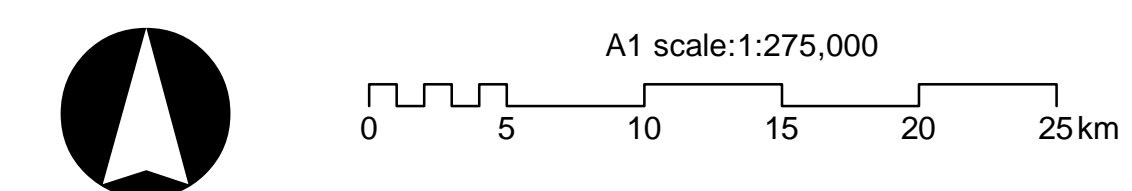
Waste and Recovered Material Haulage Route Figure 13.1 (Page 3 of 3)

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Map by: BS



GLNG No: 3381-40-0425
Coordinate system: GCS GDA 1994

13.4 Waste inductions and training

All construction personnel associated with GTP construction will be required to complete an induction. The induction training should incorporate relevant aspects of the Waste MP (refer Appendix F) and cover an individual's personal obligations with regard to the management procedures for all waste items and materials. This training will outline the importance of managing waste materials in accordance the principle of the waste and resource management hierarchy as outlined above.

13.5 Waste generation

The construction of the Mainland GTP section is not expected to generate large quantities of waste materials. The anticipated waste streams from the construction process generally fall into one of the following broad categories:

- General waste (including putrescible waste)
 - Recyclable waste such as paper, cardboard, plastics, glass, scrap metals and timber
 - Medical and first-aid waste
- Liquid waste
 - Sanitary waste
 - Hydrotest water
- Hazardous and regulated waste

The Project will adopt the waste and resource management hierarchy principles for the optimal management of all wastes generated from the Mainland GTP RoW.

13.5.1 Mainland GTP waste sources

The waste types and estimated quantities listed in Table 13.2 to Table 13.4 are expected to be generated as a result of the construction and operational activities of the approximate 406 km Mainland GTP RoW.

The waste generation lists have been compiled relative to the following key activity areas:

- Temporary Pipe Receiving Area at Gladstone Logistic Base
- Temporary Pipe Receiving Area at Port Alma
- Mainland RoW including temporary pipe storage sites and RoW access points
- Temporary construction camps including vehicle and equipment workshops

The waste types and estimated quantities listed in Table 13.2 are expected to be generated from the GTP Temporary Pipe Receiving Areas (TPRA) at the Gladstone Logistics Base and Port Alma respectively. All waste and recyclable material will be collected and stored in the designated waste storage area at the TPRA or logistics base for separation into bins or containers for regulated waste, recyclable material and general waste. The material will be collected by licensed waste contractors and hauled to an appropriate recycling or disposal destination. Proposed waste haulage routes, local waste disposal facilities and GTP features are shown on Figure 13.2.

Table 13.2 Waste generated at temporary pipe receiving areas at Gladstone Logistic Base and Port Alma

GTP construction activity	Material used/ waste generated	General management principal	Estimate of waste quantity/rate of generation at each TPRA
Delivery of plant and equipment to site (ie light vehicles and construction vehicles, dongas, portable toilets)	Packaging (ropes and strapping, cardboard), timber skids, fibre/nylon rope spacers, pallets, drums and scrap metals	Materials treated as per waste hierarchy with general waste disposed to local licensed landfill	Negligible
Delivery of pipe at port to temporary pipe receiving area	Pipes with irreparable defects or specification non-conformity or damage Pipe will arrive with PVC or polyethylene end caps and 3 pieces of nylon rope tied around each end and in the centre. These will remain on the pipe until stringing and welding is undertaken within the RoW	All dunnage and damaged pipe sections will remain on ship	Negligible
Site office	General waste, waste paper	General waste to local licensed landfill Recyclable material to recycling facility (where available)	General waste 240 L per week
Prefabrication workshop valve assemblies, pipe supports and light structures (not applicable to Port Alma)	Waste materials such as pipe spools, various off cuts and grindings, paint containers, welding waste	Recycle metals General waste to local licensed landfill	Pipe off cuts and waste steel 0.5 tonnes per week (approx one 12 m length of pipe per week) General industrial waste 0.5 tonnes per week

The waste types and estimated quantities listed in Table 13.3 are expected to be generated from Mainland GTP RoW construction activities. All waste and recyclable material generated along the Mainland GTP will be collected and transferred from the RoW by road haulage to the relevant construction camp waste storage areas for separation into bins or containers for regulated waste, recyclable material and general waste. The material will then be collected by waste contractors and hauled to an appropriate recycling or disposal destination.

Table 13.3 Waste generated from the Mainland RoW construction area and temporary pipe storage sites

Mainland GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate of generation
Mobilisation activities			
Translocation of plants (refer Significant Species Management Plan (SSMP refer Chapter 9))	Plastic pots Wooden stakes Packaging material	All existing fencing removed from the ROW during the construction phase will be offered to local landowners for reuse. Any remaining	10 m ³ per week of general and recyclable waste during fencing works
Weed control	Chemical containers and other consumables		

Mainland GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate of generation
Delivery of plant, equipment and portable structures to site (ie vehicles, dongas, portable toilets, vehicle weed washdown facilities at RoW access points (approx 11 within the Mainland GTP section))	Packaging (ropes and strapping, cardboard), timber skids, wooden crates, fibre/nylon rope spacers, pallets, drums and scrap metals	items will be removed in accordance with the principles of the waste hierarchy Recyclable material to recycling facility (where available) General waste to local licensed landfill	
Installation of fencing and gates (temporary and permanent) and removal of existing fencing as per Landholder agreements	Damaged fencing, fencing wire off cuts, timber post off cuts Temporary fencing that cannot be reused	Licensed contractor to transport regulated waste to an appropriately licensed recycling facility and residual material disposal at appropriately licensed regulated waste landfill	
Construction			
Hardstand - import of hard standing materials for roadway or hardstand construction	Hardstand materials	Surplus clean material will be offered to local landowner for reuse or removed in accordance with the principles of the waste hierarchy	No waste materials are expected to be generated
Weed washdown facilities (approx 11 washdown bays along the Mainland GTP section)	Wastewater Sludge	Water is filtered and reused in washdown facility Sludge disposed at local licensed landfill or WWTP	1 m ³ sludge per week per washdown facility
Clearing and grubbing of the pipeline corridor, pipe laydown areas (temporary pipe storage sites) and access tracks (clear and grade)	Green waste (felled vegetation and plant matter) Topsoil and excavated material (stockpiled for backfilling and application to RoW) Installation of temporary fencing and gates Construction of access tracks as required Steel post offcuts (from signage installation)	Stockpiled/windrowed vegetation will be reapplied during restoration/rehabilitation of RoW (additional detail in Chapter 15) All topsoil and excavated material reused for backfilling in RoW Any surplus fencing material will be offered to local landowners for reuse or removed in accordance with the principles of the waste hierarchy	Included in general waste in mobilisation activities
Construct pipe laydown areas (temporary pipe storage sites) – grading and levelling, hardstand, berm construction, and fencing where required	Polyethylene sheeting off cuts Cardboard or plastic tubes Plastic wrapping	Surplus clean material will be offered to local landowners for reuse or removed in accordance with the principles of the waste hierarchy	Included in general waste in pipe construction works

Mainland GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate of generation
Erosion and sediment control installation and maintenance	Packaging material – cardboard, plastic wrapping, wooden pickets and geofabric sediment fencing Geofabrics "Bidim" A34 grade polyester filter off cuts	Sediment collected in devices stored in the ROW for respreading during rehabilitation works General waste to local licensed landfill	Quantities of waste dependent on climatic, site and topography conditions Included in general waste in mobilisation activities
Drilling and blasting	Packaging – cardboard, plastic wrapping	Specialist contractors will manage all waste associated with the handling and storage of explosives in accordance with relevant legislation and standards AS2187	Recyclable wastes will be recycled and drilling and blasting contractor will be responsible for management of non-recyclable waste
Delivery of pipe construction materials and consumables to temporary pipe storage sites (road transport from Port Alma to the pipe laydown locations on the Mainland RoW)	Neoprene plastic wrapping Nylon rope Rubber matting Packaging – timber dunnage ² , pallets and crates, plastic wrapping, metal and plastic strapping around consumables Ropes and strapping, cardboard, timber skids, fibre/nylon rope spacers, pallets, drums and scrap metals	Materials will be recycled where possible General waste to local licensed landfill	Included in general waste in pipe construction works

² Dunnage is materials used in holds and containers to protect goods and their packaging from moisture, contamination and mechanical damage

Mainland GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate of generation
Pipeline construction works <ul style="list-style-type: none"> • Pipe stringing and bending • Pipe cutting and trimming • Pipe welding (up to 1000 m pipe strings) • Weld sandblasting • Tie-ins (above ground or in-the-trench) • Coating of field joints - application of rust proofing agent required to be applied when pipe is cut and a coating of epoxy-urethane over weld • Holiday detection survey and weld testing • Ducting for fibre optic cable • River/waterway crossings 	PVC or polyethylene pipe end caps (68,000 pipe end caps for pipeline) 42" mild steel pipe off cuts and defective pipe; metal filings(less than 100 m of pipe for pipeline) Timber skids and sand bags (reuse on each 30 km section) Off cuts – duct for future installation of fibre optic cable Marker tape Chemical containers (ie paint/epoxy coating cans, empty containers of rust proofing agents) Sandblasting grit (inert) Welding residue – welding rod scraps and electrode butts Polypropylene bags Waste cement and concrete Nylon rope	PVC or polyethylene pipe end caps recycled Metal recycled Timber skids and sand bags reused General waste to local licensed landfill Licensed contractor to transport regulated waste to an appropriately licensed recycling facility and residual material disposal at appropriately licensed regulated waste landfill	17.5 t per week of pipe end caps (10 kg per pipe end) 0.6 t per week of steel pipe off cuts and defective pipe 1.7 t per week of metal filings 8 t per week of general waste 100 L per week of regulated waste (spent chemicals and chemical container)
Trenching and bulk earthworks Foam trench breakers and foam pillows installation	Excavated material Excess rigid polyurethane foam (Aptane P220/Isocyanate B900) and hose washings Spent absorbent material Drums/plastic bags (polypropylene) PPE - Protective gloves and disposable overalls PVC conduit offcuts	All excavated material reused for backfilling in RoW General waste to local licensed landfill	Included in general waste in pipe construction works
Pipe cleaning and gauging Pipe testing – Hydro testing 24 hour leak test	Pipe cleaning waste (pigging grit - scale, rust, or other foreign material) Hydrostatic test water, corrosion inhibitor and oxygen scavengers (25 km tested at a time (90 kL water required), used 4 times before discharge)	Pigging grit - Licensed contractor to transport regulated waste to an appropriately licensed regulated waste landfill Hydrotest water discharge to land (assume no chemical treatment of water is required as source is potable water)	200 m ³ pigging grit total (assume 500 L per km) 360 kL water

Mainland GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate of generation
<p>Infield servicing and maintenance of construction vehicles and equipment</p> <p>Fuel trucks, lubrication trucks and minor maintenance pick-ups provide on-site daily service and perform regular check ups on equipment</p> <p>Daily field servicing, safety checks and refuelling in the field to be undertaken in the RoW</p>	<p>Oily rags, spent absorbent material from infield servicing and maintenance</p> <p>Waste oil and greases eg lube oil, hydraulic oil and engine oil</p> <p>Spent spill kit materials</p> <p>Packaging from replacement parts</p> <p>End of life vehicle parts (eg fan belts, hoses, other machinery parts)</p> <p>Tyres</p> <p>Batteries</p> <p>Used chemicals – chemicals, used tins from solvents, degreasing agents, lubricants</p> <p>Waste associated with diesel generator operation and maintenance</p>	<p>Licensed contractor to transport regulated waste to an appropriately licensed recycling facility</p> <p>Residual material dealt with in accordance with the principles of the waste hierarchy</p>	<p>All waste generated from infield servicing will be returned to the waste storage area at Preventative Vehicle Maintenance Workshop (PVMW) at the construction camps</p> <p>Refer Construction Camp Table for quantities</p>
<p>Site offices, crib room/s, site amenities (servicing of construction site amenities)</p>	<p>Office waste – paper, cardboard packaging etc</p> <p>Kitchen waste</p> <p>Rubbish bin waste in facilities (ie paper towels etc)</p> <p>First aid waste</p> <p>Kitchen and amenity wastewater</p>	<p>Recyclable material to recycling facility (where available)</p> <p>General waste to local licensed landfill</p> <p>Wastewater from crib rooms and amenities hauled via vacuum truck and disposed at construction camp's WWTP</p>	<p>Recycling and general waste quantities included in the construction camp per person kg per week</p> <p>Wastewater volumes included in construction camps quantities per person per day</p> <p>Refer Table 13.4 for construction camp wastes</p>
<p>Spill clean up</p>	<p>Hydrocarbon contaminated soil (small quantities)</p> <p>Contaminated absorbent material from RoW</p>	<p>Licensed contractor to transport regulated waste to an appropriately licensed recycling facility and residual material disposal at appropriately licensed regulated waste landfill</p>	<p>Up to 160 L per week of regulated waste across Mainland GTP activities</p>

RoW rehabilitation

Mainland GTP construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate of generation
<p>Clean up and restoration: reinstatement of the RoW, removal of foreign material (construction material and waste), surface contouring, compaction, re-spreading topsoil, re-spreading felled vegetation(whole or mulched) and reseeding</p> <p>Removing any surplus materials, restoring services to their original condition, disposing of refuse, smoothing disturbed earth, removing temporary fills, culverts and bridges, and performing such work as may be necessary to restore RoW to original condition</p>	<p>Any recyclable or general waste items listed above</p> <p>Useable surplus line pipe will be delivered to a location designated by GLNG Operations</p>	<p>Clean hardstanding material will be offered to local landowner or local council for reuse or removed for treatment or disposal in accordance with the principles of the waste hierarchy</p> <p>Useable surplus line pipe and other reusable materials stored at location designated by GLNG Operations</p> <p>Residual material dealt with in accordance with the principles of the waste and resource management hierarchy</p> <p>General waste to local licensed landfill</p>	<p>100 t timber skids</p> <p>50 t sand bags (assume timber skids and sand bags are reused approx 15 times over the length of the pipeline ie assume reuse on each 30 km section)</p>
<p>Reinstatement of temporary pipe storage sites/pipe storage yards and other non RoW areas such as haul roads, spoil storage and other such areas requiring restoration</p>	<p>Polyethylene sheeting from pipe storage area</p>	<p>Reused or recycled where possible. Will be offered to local landowners for reuse</p> <p>General waste to local licensed landfill</p>	<p>80 tonnes of PE sheeting from temporary pipe storage sites</p>
<p>Establishment of vegetation</p>	<p>Plastic pots</p> <p>Wooden stakes</p> <p>Packaging material</p> <p>Herbicides</p>	<p>Residual material dealt with in accordance with the principles of the waste hierarchy</p> <p>Items will be recycled where possible if no option available then waste will be disposed of to a local licensed landfill</p> <p>Licensed contractor to transport regulated waste to an appropriately licensed recycling facility and residual material disposal at appropriately licensed regulated waste landfill</p>	<p>50 kg per week during vegetation establishment activities in the RoW</p> <p>Quantity dependent upon whether herbicides for weed control are required during establishment of vegetation</p>

Temporary construction camps

Appropriately sized temporary construction camps will be constructed to accommodate the temporary workforce employed during the GTP construction process. It is envisaged that camps will be established in four locations. It is anticipated that at any one time there will be one major camp to accommodate up to 450 personnel and two smaller camps capable of accommodating approximately 200 personnel, one in advance of the construction works and one behind.

The temporary construction camps will be operated throughout the entire construction period; however the numbers of personnel will fluctuate during the construction program. Temporary construction camps will generate general and putrescible wastes along with recyclables, sewage, grey water and other wastes as described in Table 13.4.

A preventative vehicle maintenance workshop (PVMW) will be established at each temporary construction camp as required to provide first and second level maintenance for construction vehicles.

All waste materials generated within the temporary construction camps will be segregated and appropriately stored within a designated waste management area in accordance with Australian Standards prior to transport off-site by a suitably licensed waste contractor.

The waste types and quantities listed in Table 13.4 are expected to be generated from the temporary construction camp activities in the Mainland section.

Table 13.4 Waste generated from temporary construction camps

Construction camp construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate of generation
Mobilisation, construction and commissioning of construction camps	Site clearance green waste, topsoil and excavated material (stockpiled for backfilling and application to construction camps)	Stockpiled/windrowed vegetation will be reapplied during restoration/rehabilitation of RoW (additional detail provided in Chapter 15) All topsoil and excavated material stockpiled along RoW for backfilling and spreading during site restoration	Nil
	Construction materials, concrete, scrap metal, timber, plastics, plumbing, electrical wiring etc	The construction methodology will aim to limit the amount of waste produced on the construction site and ensure that wherever possible, waste materials are re-used or recycled General waste to local licensed landfill	20 m ³ per week general and recyclable waste per construction camps during construction camp set up activities
Operation of construction camps – cleaning, catering, site offices, accommodation areas, RoW, temporary pipe storage sites, construction areas, temporary storage, residential blocks	General waste (including putrescible and non-hazardous Waste) Recyclables (Dry recyclables, cardboard, packaging materials and offices wastes)	Recyclable material to recycling facility (where available) General waste to local licensed landfill	6 kg per person per week recyclable material 13 kg per person per week general waste
	Metals - aerosol, aluminium cans, steel chemical containers, copper and aluminium (other than cans), steel drums (damaged), steel drums (good condition), scrap steel, steel chemical containers, bulk food containers		

Construction camp construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate of generation
	Food waste- putrescible waste, metal, plastic, plastic and other associated food packaging		
	Chemicals - Cleaning and maintenance of camp buildings chemicals		
	Cardboard – Bulk food packaging, and Preventative Vehicle Maintenance Storage (PVMS)		
	Cooking oils – Food production activities	Waste cooking oil will be securely stored by the catering contractor and removed by the supplier for recycling where practicable	Recycling and general waste quantities included in the per person kg per week
	Wood (Pallets) bulk deliveries of food	All pallets will be collected by suppliers and returned for reuse	
	Clinical, medical, sanitary, waste first-aid station waste, medical waste (Medical Centre)	Waste material dealt with in accordance with the principles of the waste hierarchy	Minimal quantities expected to be produced and have been included in the per person general waste quantities
	Wastewater treatment plant effluent	Discharge to mobile sewage treatment plants – irrigation beds/absorption beds	200 L per person per day - Effluent
	Sludge from wastewater treatment plant	Appropriately licensed landfill or wastewater treatment plant	5 L sludge per person per week at 2% solids
Site mowing and vegetation maintenance	Green organic waste (Woody garden waste, grass)	Green waste, whole or mulched, will be stockpiled and reapplied during restoration / rehabilitation of construction camp (additional detail in Chapter 15)	No waste expected to be generated
Office waste, construction materials and equipment store	Spent toner and printer cartridges, electronic and electrical equipment, white goods, computers, office equipment, mobile phones, batteries (Dry Cell)	Equipment will be reused by returning items to Brisbane	Minimal – each Office will only be operational 6 to 9 months. Recycling and general waste quantities included in the kg per person per week
	Spent lamps and fluorescent tubes	Recyclable material to recycling facility (where available)	Recycling and general waste quantities included in the kg per person per week
	Paper – office paper, other sources of packaging	General waste to local	

Construction camp construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate of generation
	General non recyclable - synthetic material waste Fibre insulation filters (Activated Carbon) filters (Air, Dust, Paper)	licensed landfill	
	Wood (Pallets) construction materials, and other equipment	Pallets will be collected by suppliers during subsequent deliveries and returned for reuse	
Preventative vehicle maintenance (PVM) service areas / workshop			
Vehicle wash down	Wastewater Sludge	Water will be reused at the vehicle wash facilities Sludge disposed at local licensed landfill or WWTP	0.5 m ³ sludge per week per construction camp wash down facility
Delivery of bulk equipment and supplies	Packaging (Ropes and strapping, cardboard), timber pallets, fibre/nylon rope, drums and scrap metals	All packaging materials such as pallets will be collected by suppliers and returned for reuse or dealt with on site as per the principles of the Waste Hierarchy General waste to local licensed landfill	0.5 tonnes per week of packaging material
Refuelling – Diesel Generators	Absorbent material	All waste will be stored in accordance with Australian Standards AS 1940 in appropriately banded areas	No waste expected to be generated (absorbent material listed below)
Diesel refuelling area for construction vehicles - fuel storage up to three 30 kL tanks at construction camps for refuelling construction vehicles	Absorbent material	All waste will be stored in accordance with Australian Standards in appropriately banded areas	Minimal quantities expected to be generated
Vehicle maintenance workshop	Filters (oil) filters (air, dust, paper)	Collected and transported by a suitably licensed contractor for recycling where possible	100 kg per week oil and air filters
	Batteries (Wet lead acid)	Collected and transported by a suitably licensed contractor for recycling where possible	Up to 50 batteries are expected for the duration of the project based on PVM schedule
	Oils and oil contaminated waters - waste oil, oily absorbents, oily rags, oily sludge's, sump oils, grease traps	Collected and transported by a suitably licensed contractor for recycling or disposal to regulated waste landfill	Up to 3,000 L per week of waste oil 160 L per week of oily rags and absorbent material
	Rubber – Tyres	Collected and transported by a suitably licensed contractor for recycling	Up to 20 tyres per week

Construction camp construction activity	Material used/ waste generated	General management principle	Estimate of waste quantity/rate of generation
Prefabrication workshop valve assemblies, pipe supports and light structures	Waste materials such as pipe spools, various off cuts and grindings, paint containers, welding waste	Recyclable material to recycling facility (where available) General waste to local licensed landfill	Pipe off cuts and waste steel 0.5 t per week General industrial waste 0.5 t per week
Restoration and rehabilitation (decommissioning of construction camps)	Construction materials, concrete, scrap metal, timber, plastics, plumbing, electrical wiring	On decommissioning any remaining material will be offered to local landowner for reuse or removed for treatment or disposal in accordance with the principles of the waste and resource management hierarchy	Minimal amounts The construction methodology will aim to limit the amount of waste produced during construction of the construction camps and will encourage that materials are re-used or recycled, wherever possible

13.5.2 Operational waste

It is not anticipated that significant quantities of waste will be generated during operation of the Mainland GTP RoW. However waste will still be generated from maintenance activities. The waste types generated will include putrescible waste, recyclable wastes (including paper, cardboard, plastics, glass and aluminium) and sanitary waste.

The activities that are expected to be undertaken during operation of the Mainland GTP RoW include maintenance and repairs of the GTP and weed/vegetation management along RoW access tracks. A list of the waste types and an estimate of the waste quantities generated from operational activities is detailed in Table 13.5.

Table 13.5 Waste generated from Mainland GTP RoW operation

Mainland GTP operation activity	Waste generated	General management principle	Estimated waste quantity/rate of generation ³
Maintenance of Mainland GTP	Filters (non-oily, oily and gas)	Collected and transported by a suitably licensed contractor for recycling or disposal to regulated waste landfill	350 kg per year (approx 0.8 kg/km/year based upon 30 kg/month for entire pipeline)
	Waste oils and greases	Collected and transported by a suitably licensed contractor for recycling where possible	5 m ³ per year (about 10 L per km)
	Packaging	General waste for disposal at appropriately licensed landfill	1,500 kg per year (approx 3.6 kg/km/year based upon 30 kg per week for entire pipeline)

³ Estimated operational waste quantities are based upon proportions

Mainland GTP operation activity	Waste generated	General management principle	Estimated waste quantity/rate of generation ³
Cleaning of pipeline - pigging (if undertaken in the future)	Pipe cleaning waste (pigging grit - scale, rust, or other foreign material)	Pigging grit - Licensed contractor to transport regulated waste to an appropriately licensed regulated waste landfill	8 m ³ pigging grit per year (assume 20 L per km)
Spills of hydrocarbon based material	Potential hydrocarbon contaminated soil from spills oils and greases	Remediation in situ for small quantities. Advice sought from DERM regarding treatment options for larger spills (eg >200 L) Removal of soil under disposal permit for remediation or disposal at suitably licensed facility	No waste materials are expected be generated
Offices, crib room/s, site amenities along pipeline	Office waste – paper, cardboard packaging etc Kitchen waste Rubbish bin waste in facilities (ie paper towels etc) First aid waste Kitchen and amenity wastewater	Recyclable material to recycling facility (where available) Residual material local licensed landfill Wastewater from crib rooms and amenities will be hauled via vacuum truck and disposed at a local WWTP	1,500 kg per year recyclable material and general waste (approx 3.6 kg/km/year based upon 30 kg per week for entire pipeline) Small quantities of wastewater are expected. Portable amenities to be serviced weekly when in use

13.5.3 Decommissioning waste

The rehabilitation of the GLNG RoW including the Mainland GTP RoW and associated infrastructure is not expected to generate large volumes of waste. The GTP has a design and operation life of approximately 42 years.

Prior to final decommissioning or abandonment of any facilities associated with the GTP, GLNG Operations will investigate potential environmental issues and impacts associated with decommissioning or abandonment. Infrastructure that is no longer required for the operation of the Mainland GTP RoW will be decommissioned as per the decommissioning methods discussed in Chapter 2.

Prior to the decommissioning of the Mainland GTP RoW, a detailed assessment of the types and quantities of waste materials which could be expected will be conducted. Typical waste materials which would require removal from the above ground facilities would comprise metal pipework and valves, and inert wastes such as concrete and hard standing material from mainline valve stations.

It is likely that above ground materials such as signs and some fencing would be disposed of in accordance with the principles of the waste and resource management hierarchy. Refer to Chapter 2 for an outline of decommissioning and abandonment.

13.6 Chemical use and management

The Mainland GTP RoW project construction and operation activities will require the use of chemicals and hazardous materials, and generate waste chemicals and hazardous materials.

Chemical and hazardous materials associated with the Mainland GTP RoW activities will be handled and stored in accordance with the applicable State or Commonwealth legislation (refer Chapter 1), Australian standards and guidelines (refer Chapter 2 and the Waste MP). This will include the separate storage of waste chemicals in appropriate containers at designated storage areas to encourage reuse, recycling and enable correct transport, treatment and disposal.

Environmental protection commitments, objectives and control strategies for chemical and hazardous materials management have been developed, including flammable and combustible liquids these are detailed in Table 13.6.

Table 13.6 provides a list of the chemicals and hazardous materials to be stored and used during the Mainland GTP RoW construction. A description of the relevant activity and the proposed storage location is listed.

Table 13.6 Summary of possible chemical and hazardous materials for use during construction

Chemical/hazardous material	Activity	Anticipated storage location
Diesel	Fuel for construction vehicles and machinery and diesel generators at construction camps and offices	Storage tanks located at construction camps Up to a total storage capacity 90,000L at each construction camp (3 x T30 fuel tanks (30,000L each))
Fuel dispenser pump and storage (gasoline); Fuel dispenser pump and storage (diesel);	Fuelling facilities for vehicles	Gladstone Logistic Base at Gladstone Port Central 50,000 L fuel tank for fuel filling station
Fertiliser	Translocation of plants and restoration of the RoW	Construction camps storage area and Gladstone Logistic Base
Herbicides (chemicals registered for the specific weed to be controlled)	Chemical spraying of weeds	Construction camps storage area and Gladstone Logistic Base
Rigid Polyurethane foam (Aptane P220/Isocyanate B900)	Foam trench breakers and foam pillows installation – to hold the pipe off the trench invert (alternative material - sand bags)	Specialist subcontractors will mobilise foam components to site in storage containers on vehicles. Subcontractors to provide documentation regarding storage, handling and disposal arrangements prior to bringing to site.
Oils and greases	Infield preventative vehicle servicing and maintenance of construction vehicles and equipment Major repair and maintenance of construction equipment at the temporary maintenance workshop at the Gladstone Logistic Base.	Construction camp and Gladstone Logistic Base storage area in suitably sized tanks within appropriately banded compounds as per Australian Standards.
Waste Oil	Minor repairs and maintenance of construction equipment at the Preventative Vehicle Maintenance (PVM) workshop within Gladstone Logistic Base	All waste oils will be collected and stored within appropriately sized and banded storage containers within the Construction Camps PVM workshop.
Emulite (bottom charge) Prillite (column charge) Nonel U175 or U500 detonators, Nonel UB,42 UB17, UB25	Blasting	Specialist subcontractors mobilise blasting materials to site. Handling, storage requirements and disposal methods to be documented by the appointed specialist subcontractor ie Australian Standards 2187

Chemical/hazardous material	Activity	Anticipated storage location
Paint	Painting welds and pipe coating defects	Storage area at Construction camps
Fusion bond epoxy powder	Coating for welded field joints	Storage area at Construction camps
Polyurethane-tar coating compound	Field joint coating	Storage area at Construction camps
Oxygen scavenger	Chemical dosing during Hydrotesting	Storage area at Construction camps
Biocide	Hydrotesting	Storage area at Construction camps
Radioactive isotope/material/element within weld inspection device (pipe crawler)	Weld inspection activities	Contained in pipe crawler machine. Pipe crawler located at RoW or in equipment storage area at the Construction camps. Specialist subcontractors will maintain documentation and certificates to bring such materials to site and are responsible for handling, storage requirements and identification of disposal methods.
	Non-Destructive Testing (NDT) X-Ray films development for weld quality assurance	Darkroom, containing the necessary film processing equipment, will be located at the Construction camps. Specialist subcontractors will manage such materials on site and be responsible for handling, storage and disposal methods
Wastewater treatment plant chemicals	Construction camp wastewater treatment	Storage area at construction camps as per Australian Standards

Table 13.7 provides a list of the chemicals and hazardous materials to be stored and used during the Mainland GTP RoW operation along with the relevant activity and the proposed storage location.

Table 13.7 Chemical and hazardous materials proposed for use during operation

Chemical/hazardous material	Activity	Storage location
Lubricants	Maintenance of mainline valve stations	GLNG GTP operations headquarters in Gladstone
Solvents	Cleaning pigging equipment and sumps	GLNG GTP operations headquarters in Gladstone
Oils and greases	Maintenance of equipment for pipeline maintenance	GLNG GTP operations headquarters in Gladstone

13.7 Potential adverse or beneficial impacts on existing environmental values (construction and operation)

The Queensland Government provides environmental legislation which details the framework for the management of waste emissions to the environment in Queensland. The legislation outlines the waste management hierarchy⁴ as an optimal waste management tool. The waste and resource management hierarchy principles are addressed in more depth in the GTP Waste MP (refer Appendix F).

13.7.1 Potential impacts on values from the Mainland GTP section

Existing environmental values that may be impacted by the generation of waste as a result of Mainland GTP RoW construction activities include:

- Life, health and wellbeing of people and the community
- Diversity of ecology and associated ecosystems
- Land use capability, having regard to economic considerations
- Management of finite resources

The nature of the Project will create liquid, solid and gaseous wastes as a result of the construction, operation and decommissioning phases of the mainland GTP RoW. Typical wastes which will be generated include regulated, general, recyclable and inert waste.

The correct management of waste in accordance with the waste hierarchy and relevant State and Commonwealth legislation and standards, will reduce the risk of harm to staff, community and the environment. The potential impacts include the following:

- Water (surface water and groundwater) contamination from unsuitable storage, handling, spills and disposal of solid and liquid wastes
- Land contamination from spills during handling and transportation of liquids and solid waste
- Increased occurrences of vermin due to unsuitable storage and handling of putrescible wastes
- Impact on visual amenity due to poor maintenance and housekeeping along the RoW
- Wasteful use of finite resources
- Adverse effects to flora and fauna

Table 13.8 details the potential impacts of waste activities associated with construction of the Mainland GTP RoW. Further details of the existing environmental values of the Mainland GTP that have the potential to be affected by waste are provided throughout this EM Plan.

⁴ Waste and resource management hierarchy as described in section 13.3.

Table 13.8 Summary of impacts on the environmental values associated with the construction of the Mainland GTP section

Aspect/source/activity	Potential impacts
Inappropriate waste management and disposal	Soil, groundwater, surface and water contamination, ambient air quality impact
Disposal of sewage wastewater and other liquid wastes from project-related sources (eg equipment washdown stations, work area amenities)	Reduced water quality (particularly suspended solids/ turbidity, nutrients and microbiological contaminants) with consequent reduction in: <ul style="list-style-type: none"> • Suitability of water for drinking • Aquatic habitat quality including fish resources • Temporary loss of land use for economic use • Potential contamination of surface water and/or groundwater • Loss or damage to local ecosystem
Spillage of oil/ fuel/ chemical during transport, storage, handling or refuelling	Loss of oil/ fuel/ other hazardous material to air, surface water, groundwater, soil and/or sediment with consequent adverse impacts on associated quality and beneficial values
Spillage of hazardous materials during transport, storage, handling and use	Loss of hazardous material to air, surface water, groundwater, soil and/or sediment with consequent adverse impacts on associated quality and beneficial values
Spill during transfer of liquid and solid waste on/off Barge	Release of hazardous material resulting in adverse environmental and health effects
Hydrotest water discharge	Adverse impacts on local water quality, surface water, drinking water, aquatic habitat quality, temporary loss of land use for economic use, excessive erosion

13.7.2 Summary of potential impacts on values from the Mainland GTP

Construction

It is considered that the potential impacts listed in Table 13.8 resulting from construction of the Mainland GTP section are expected to be acceptable and manageable as construction works will be undertaken in accordance with the control strategies as outlined in Section 13.10 and the Waste MP (refer Appendix F).

Operation

It is considered that related impacts resulting from the operation of the Mainland GTP section are expected to be acceptable and manageable due to the low volumes of waste produced and because operational activities will be undertaken in accordance with the Waste MP (refer Appendix F) and an Operational Management Plan (OMP) that will be developed and implemented prior to the completion of construction.

13.8 Continuous improvement

GLNG Operations will work closely with the Contractor to rectify any issues identified as a result of waste monitoring and auditing activities.

GLNG Operations will continue to investigate and implement actions to reduce impacts and deliver positive outcomes through the operation of the GTP in relation to waste management.

The results of inspections, audits and incident reports will be used to drive continuous improvement along with other associated internal environmental performance reviews conducted by the GTP management team.

Following any significant changes to the GTP design or operational processes, the Waste MP (refer Appendix F) will be reviewed to determine if it should be updated to reflect the changes.

Following any environmental incidents resulting in environmental harm, the Waste MP will be reviewed and mitigation measures updated and improved to reduce the risk of incidents.

The Waste MP will be subject to annual review by GLNG Operations and its effectiveness in managing the waste streams associated with the GTP operations reported internally and to any relevant stakeholder.

13.9 Cumulative impacts

Cumulative impacts associated with waste management are described below. This cumulative impact assessment is based on the impact scope, identification and scoring methodology described in Chapter 2 of this EM Plan. Potential impacts may arise from increased waste generation from the projects. These may include hydrotest water, generation of solid waste and vegetation waste.

13.9.1 Liquid waste (hydrotest disposal)

It is assumed that disposal of hydrotest water is managed in accordance with proposed waste management plans. Given this and the fact that hydrotest water from each project will be disposed of as a discrete, short term event and localised to each area, cumulative impacts from liquid waste disposal are expected to be minimal.

There will be minimal negative cumulative impacts from hydrotest water disposal.

13.9.2 Solid waste (creation of spoil material/vegetation waste)

Vegetation waste will be generated from the clearing of the ROW. All proponents have committed to mulching and re-using vegetative material where possible, which will reduce the total amount of waste requiring disposal.

Given this, it is assumed that cumulative impacts from spoil material and vegetation waste that will need to be disposed in a waste receptacle will be negligible.

There will be negligible negative cumulative impacts from solid waste.

13.9.3 Liquid waste (HDD fluid disposal)

Drilling fluids and cuttings will be required for the HDD and will require disposal once drilling is complete. No disposal of HDD fluids and cuttings would be permitted to the local surface water.

There will be minor cumulative impacts from HDD fluid disposal.

13.9.4 Solid waste (general)

General waste from the temporary construction camps will be stored onsite and disposed in local landfills. Waste will be recycled where possible, reducing the potential cumulative impact to landfill.

Cumulative impacts may occur if landfill sites are not able to cope with the volume of waste generated by the projects, however given that waste will be managed discreetly for each project and assuming that waste is managed according to proposed waste management plans, cumulative impacts from general waste will be minor.

There will be minor negative cumulative impacts from solid waste.

13.9.5 Solid waste (sanitary waste)

Sanitary waste generated from multiple temporary construction camps will be treated onsite by individual projects, which will minimise cumulative impacts to the local sewage system.

Sludge from the onsite treatment plants for each of the proponents will be disposed of in registered facilities; however, given the short timeframe of the construction phase and the relatively limited workforce for the pipelines, impacts will be minor and can be managed by liaising with local councils and water authorities.

There will be minor negative cumulative impacts from sanitary waste.

13.10 Environmental protection commitments, objectives and control strategies – waste management (construction and operation)

The environmental protection commitments, objectives and control measures listed in Table 13.9 to Table 13.11 have been provided for the management of the following waste and chemical issues:

- Waste
- Hydrotest water
- Chemicals and hazardous materials

Waste management

Table 13.9 details the environmental protection objectives, strategies, monitoring and reporting requirements for the management of construction waste.

Table 13.9 Environmental protection commitments, objectives and control strategies for waste management

Item	Detail
Environmental protection objective	<ul style="list-style-type: none"> • To ensure that the transmission pipeline construction adheres to the waste management hierarchy of avoid, reuse, re-use and recycle. Where this is not possible, to dispose of waste in the most appropriate manner
Specific objectives	<ul style="list-style-type: none"> • No inappropriate disposal or management of waste • No contamination of soil, air or water as a result of waste handling • Petroleum activities do not result in the release or likely release of contaminants to the environment from the storage, conditioning, treatment and disposal of regulated waste materials
Control strategies	<p>General</p> <ul style="list-style-type: none"> • Prior to commencement of works, the appropriate methods for disposal of waste will be determined by consultation with the relevant local governments and the Department of Environment and Resource Management • A waste management plan in accordance with the Environmental Protection (Waste) Policy 2000 on the following will be developed and implemented including: <ul style="list-style-type: none"> – The types and amounts of waste generated – How the waste will be dealt with, including a description of the types and amounts of waste that will be dealt with under each of the waste management practices mentioned in the waste management hierarchy (section 10 of the Environmental Protection (Waste Management) Policy 2000) – Procedures for dealing with accidents, spills and other incidents that may impact on waste management

Item	Detail
	<ul style="list-style-type: none"> – How often the performance of the waste management practices will be assessed (ie at least annually) – The indicators or other criteria on which the performance of the waste management practices will be assessed • On completion of each section of pipeline, all waste material will be removed from the workplace. No wastes will be buried or disposed of on-site without local government and DERM approval • The Construction Contractor will advise designated disposal areas for each section of the RoW • All welding waste will be managed appropriately and removed from the RoW on an as required basis • General waste will be collected and transported generally to local council approved disposal sites • Food wastes will be collected, where practicable, considering health and hygiene issues, for disposal off-site • All waste/rubbish will be correctly disposed of and will not pose a risk to marine fauna. Plastic bags will be banned from all site offices and project areas within the coastal zone (intertidal and marine zones) • Refuse containers will be located at each worksite • Where practical, wastes will be segregated and reused / recycled (eg scrap metal) • All personnel will be instructed in project waste management practices and procedures as a component of the environmental induction process • Suppliers will be requested to minimise packaging where practicable • Emphasis will be placed on housekeeping and all work areas will be maintained in a neat and orderly manner • All equipment and facilities will be maintained in a clean and safe condition <p>Liquid waste</p> <ul style="list-style-type: none"> • Wastewater from construction, cleaning and testing operations will be treated and managed in accordance with the relevant environmental authorities • Sewage or grey water will either be collected for treatment and disposal off-site or treated via an on-site treatment system and disposed of to effluent absorption beds or irrigation fields, with treated sewage effluent generally to be disposed of by irrigation • The treatment method will be selected in consultation with a relevant local authority and DERM and the relevant environmental authority obtained • Prior to commencement of works, the Contractor must determine from all relevant local governments, any additional upgrades of sewerage or waste disposal facilities required as a result of this project's requirements for workers' accommodation and meet any costs associated with these upgrades • Prior to discharge of treated wastewater to land, the Contractor must submit a copy of the WIMP to GLNG Operations within a sufficient timeframe to obtain approval from the administering authority allowing for review and comment and having due regard to that comment in the finalisation of the plan • The release of contaminants from the sewage treatment plant to land must comply, at the sampling and in situ monitoring point(s) with each of the limits specified in Table 1 for each quality characteristic

Item	Detail			
	Table 1 Release Quality Characteristics for Discharge to Land			
	Quality Characteristics	Release Limit	Limit Type	Monitoring Frequency
	Total-N	3 mg/L	50 percentile Compliance	Weekly
	Total-N	10 mg/L	Maximum	Weekly
	Total-P	0.1 mg/L	50 percentile Compliance	Weekly
	Total-P	1 mg/L	Maximum	Weekly
	Ammonia-N	1 mg/L	50 percentile Compliance	Weekly
	5-day Biochemical Oxygen Demand	<5 mg/L	80 percentile Compliance	Weekly
	Suspended Solids	<5 mg/L	80 percentile Compliance	Weekly
	pH	6.5 – 8.0	Range	Daily
	Faecal Coliforms	5 colonies per 100ml sample	Geometric Mean	Weekly
	<ul style="list-style-type: none"> • The effluent released must not have any properties nor contain any organisms or contaminants in concentrations which are capable of causing environmental harm or an environmental nuisance • Signage must be placed around the land irrigation area and irrigation equipment warning the public that the area and equipment has been set aside for irrigation by treated effluent, which is not to be used for drinking purposes. The signs must be maintained in a visible and legible condition • Any treated effluent irrigation area must not be used for: <ul style="list-style-type: none"> – Recreational activities or as a traffic thoroughfare during irrigation – Any activity which may involve members of the public or employees without appropriate personal protective equipment coming in contact with treated wastewater during irrigation periods and for at least four hours after irrigation has ceased or until irrigated vegetation has dried • Sufficient wet weather storage should be provided for a 3 month period • When weather conditions or soil conditions preclude the irrigation of treated effluent, the treated effluent must only be discharged at nomination locations as per environmental authority • Treated sewage effluent must not be irrigated when weather or soil conditions would cause run-off or ponding of any irrigated wastewater • The amount of treated sewage effluent irrigated must be matched to the water requirements of the vegetation irrigated, without exceeding a reasonable estimation of the field capacity of the soil, in the root zone, in the irrigation area • The rate of application of treated sewage effluent to the release area must not exceed the capacity of the soil in the contaminant release area to absorb it • The irrigation of treated effluent must be carried out with a sufficient buffer distance to comply with all environmental conditions and requirements (eg contaminants release, Air quality) • Treated effluent will not be released to other parties for irrigation without written permission from GLNG Operations. The quality of the treated effluent released to other parties for the purpose of irrigation must comply, at the sampling point specified, with each of the release limits specified in Table 1 • Copies of agreements to supply treated sewage effluent from the Sewage Treatment Plant for the purpose of irrigation must be forwarded to GLNG Operations in a sufficient timeframe to be approved by administering authority 			

Item	Detail
	<ul style="list-style-type: none"> • The Contractor must prepare a Wastewater Irrigation Management Plan (WIMP) as part of the EMP. The WIMP is to be developed in accordance with the “Interim Guidelines for the Reuse of Reclaimed Wastewater in Queensland, 1996” produced by the Department of Natural Resources or the “Draft National Guidelines for Sewerage Systems: Reclaimed Water” endorsed by the National Health and Medical Research Council (NHMRC) in 2000. The WIMP should address at least, but not be limited to, the following matters: <ul style="list-style-type: none"> – The measurement of the quantity and quality of treated effluent produced by the activity – An assessment of the suitability of the area of land available for wastewater irrigation – The definition and clear identification of areas to be used for wastewater irrigation – Carrying out daily time step modelling (using MEDLI or similar) to estimate at least wastewater irrigation application rates, the wastewater irrigation area required and the volume of wet weather storage required, taking into account at local tropical climatic conditions, soils in the wastewater irrigation area and the vegetation grown in the wastewater irrigation area – An assessment of surface waters, including stormwater, that may be affected – An assessment of the characteristics of the soils in the wastewater irrigation area including assessment of nutrient and salt levels of the soils in the disposal area and how soils will be managed – An assessment of the potential impacts of odour resulting from wastewater irrigation – Management of human and fauna health issues associated with the irrigation of wastewater • Sewage treatment plants associated with temporary workers’ accommodation must be located above Q50 flood levels • The plant and equipment used for sewage treatment or disposal will be installed, maintained and operated in a proper and efficient manner by a suitably qualified and experienced person • Sewage effluent absorption beds and/or irrigation fields will be selected and designed to ensure that: <ul style="list-style-type: none"> – Sensitive areas are avoided – Soil erosion and soil structure damage is avoided to the extent possible – There is no ponding or runoff of effluent – The receiving environment has the capacity to assimilate the contaminants – There will be no discharge of treated effluent from wet weather storage to any waters • Flammable and combustible liquids (including petroleum products and associated piping and infrastructure), must be stored, handled and maintained in accordance with the latest edition of Australian Standard 1940 - the Storage and Handling of Flammable and Combustible Liquids • Any liquids stored on site that have the potential to cause environmental harm must be stored in or serviced by an effective containment system that is impervious to the materials stored and managed to prevent the release of liquids to waters or land. Where no relevant Australian Standard is available, the following must be applied: <ul style="list-style-type: none"> – Storage tanks must be bunded so that the capacity and construction of the bund is sufficient to contain at least 110 per cent of a single storage tank or 100 per cent of the largest storage tank plus 10 per cent of the second largest storage tank in multiple storage areas – Drum storages must be bunded so that the capacity and construction of the bund is sufficient to contain at least 25 per cent of the maximum design storage volume within the bund

Item	Detail
	<p>Hazardous waste</p> <ul style="list-style-type: none"> • Chemical wastes will be collected in drums (or similar sealed container) and appropriately labelled for safe transport to an approved chemical waste depot or collection by a liquid waste treatment service • Storage, transport and handling of all chemicals will be conducted in accordance with all legislative requirements • Containment bunds and/or sumps will be drained periodically to prevent overflow and subsequent pollution of the surrounding land and/or water body • All hazardous wastes will be appropriately stored in bunded areas away from watercourses and in accordance with legislative requirements • Where no Australian Standard is available, any liquid with potential to harm the environment must be: <ul style="list-style-type: none"> - Stored in impervious bunded tanks with bunded capacity at least 110% of a single storage tank or 100% of the largest storage tank plus 10% of the second largest storage tank in multiple storage areas - Impervious drum storage must have a bunded capacity to contain at least 25% of the maximum design storage volume within the bund • Hazardous wastes, such as solvents, rust proofing agents and primers will be managed in accordance with the requirements of relevant legislation and industry standards • A hazardous materials inventory will be prepared • Material Safety Data Sheets (MSDS) for hazardous materials will be available at all work sites • Hydrocarbon wastes, including lube oils, will be collected for safe transport off-site for reuse, recycling, treatment or disposal at approved locations • As soon as practicable remove and dispose of all regulated waste to a licensed waste disposal facility or recycling facility • All regulated waste removed from the site must be removed by a person who holds a current authority to transport such waste under the provisions of the Environmental Protection Act 1994 and sent to a facility licensed to accept such waste • When regulated waste is removed from within the boundary of the petroleum tenure and transported by the holder of this authority, a record must be kept of the following: <ul style="list-style-type: none"> - Date of waste transport - Quantity of waste removed and transported - Type of waste removed and transported - Route selected for transport of waste - Quantity of waste delivered - Any incidents (eg spillage) that may have occurred on route • If a person removes regulated waste associated with activities within the operational land and disposes of such waste in a manner which is not authorised or is improper or unlawful then, as soon as practicable, the administering authority will be notified of all relevant facts, matters and circumstances known concerning the disposal • If a hazardous contaminant is released to waters or land the following steps must be taken: <ul style="list-style-type: none"> - Take immediate action to stop any further release and make sure that the area is safe - Take immediate action to contain the hazardous contaminant to the affected area, taking particular care to protect environmentally sensitive areas - Restore or rehabilitate the environment to its condition before the release occurred; and take necessary action to prevent a recurrence of the release - Ensure that all health risks associated with the disposal and reuse of treated sewerage is mitigated through appropriate primary and secondary treatment
<p>Performance indicators</p>	<ul style="list-style-type: none"> • Waste handling is conducted in a way that minimises contamination of soil, air or water

Hydrotest water

Table 13.10 details the environmental protection objectives, control strategies, monitoring and reporting requirements for the management of hydrotest water.

Table 13.10 Environmental protection commitments, objectives and control strategies for hydrotesting

Item	Detail
Environmental protection objective	<ul style="list-style-type: none"> To protect the quality of local land and water resources during pipeline hydrotesting
Specific objectives	<ul style="list-style-type: none"> Appropriate permits obtained prior to drawing water No existing water sources unsustainably depleted to provide hydrotesting water No adverse impacts on soil or surface water as the result of discharging hydrotesting water
Control strategies	<ul style="list-style-type: none"> Relevant permits to draw water obtained Hydrotest water will be re-used on multiple and adjacent pipeline sections as much as possible to reduce actual volumes used Pipe sections crossing water bodies will be tested prior to installation Inspection of all pipeline section welds, or hydrotesting of pipeline sections before installation under water bodies, will be performed in accordance with construction specifications/procedures Biocides, where required, will be biodegradable Where biocides are added, discharge water will be aerated Prior to discharge, the Contractor will provide a Hydrotest Water Management Plan (HWMP) prior to commencement of construction works for the Project. The HWMP will include: <ul style="list-style-type: none"> A detailed assessment of impacts from hydrostatic test water along the pipeline route including source water quality data and characteristics of additives, particularly biocides Proposed storage, treatment and disposal methods of hydrotest water Site specific mitigation measures for management of hydrotest water including monitoring and reporting Determination of whether testing of the hydrotest water is necessary and submit a plan for review to GLNG Operations. Where the water source and water quality is known, and no chemicals have been added, water quality testing may not be required Hydrotest water will be treated as necessary and then disposed of such that it does not enter into any watercourses or run in an uncontrolled manner onto open land. Where water cannot be discharged to ground, other options will be considered to ensure compliance with all regulations Hydrotest water will be released at least 100 m from any watercourse such that vegetation and soil structure are not damaged or eroded and the quality of groundwater is not adversely impacted Discharge of hydrotesting water will comply with all regulatory and landholder requirements Where hydrostatic test water is proposed to be released to land, it will not exceed the water quality limits specified in Table 2: Water Quality Limits. Hydrostatic test water containing chemical additives must not be released to land without written consent from GLNG Operations and the administering authority

Item	Detail																										
	<p>Table 2: Water Quality Limits</p> <table border="1"> <thead> <tr> <th>Parameter</th> <th>Maximum value</th> </tr> </thead> <tbody> <tr> <td>pH</td> <td>6.5-8.5 (Range)</td> </tr> <tr> <td>Arsenic (mg/L)</td> <td>2.0</td> </tr> <tr> <td>Cadmium (mg/L)</td> <td>0.05</td> </tr> <tr> <td>Chromium (mg/L)</td> <td>1</td> </tr> <tr> <td>Copper (mg/L)</td> <td>5</td> </tr> <tr> <td>Iron (mg/L)</td> <td>10</td> </tr> <tr> <td>Lead (mg/L)</td> <td>5</td> </tr> <tr> <td>Manganese</td> <td>10</td> </tr> <tr> <td>Zinc (mg/L)</td> <td>5</td> </tr> <tr> <td>Nitrogen (mg/L)</td> <td>35</td> </tr> <tr> <td>Phosphorus (mg/L)</td> <td>10</td> </tr> <tr> <td>Electrical Conductivity (uS/cm)</td> <td>2000</td> </tr> </tbody> </table>	Parameter	Maximum value	pH	6.5-8.5 (Range)	Arsenic (mg/L)	2.0	Cadmium (mg/L)	0.05	Chromium (mg/L)	1	Copper (mg/L)	5	Iron (mg/L)	10	Lead (mg/L)	5	Manganese	10	Zinc (mg/L)	5	Nitrogen (mg/L)	35	Phosphorus (mg/L)	10	Electrical Conductivity (uS/cm)	2000
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Nitrogen (mg/L)	35																										
Phosphorus (mg/L)	10																										
Electrical Conductivity (uS/cm)	2000																										
Performance indicators	<ul style="list-style-type: none"> Permits to draw water are in place Hydrotesting water is not unsustainably depleting existing water sources Discharge of hydrotesting water is not adversely impacting on soil or surface water 																										

Chemical and hazardous materials management

Table 13.11 details the environmental protection objectives, relevant control strategies, monitoring and reporting requirements for the management of chemical and hazardous materials.

Table 13.11 Environmental protection commitments, objectives and control strategies for chemical and hazardous materials management

Item	Detail
Operational Policy or Management Objective	<ul style="list-style-type: none"> To ensure that storage and handling of chemicals and dangerous goods does not cause environmental harm or harm to persons
Performance Criteria	<ul style="list-style-type: none"> Petroleum activities do not result in the release or likely release of a hazardous contaminant to the environment Storage and handling procedures correct and appropriate Chemicals stored in secure areas All containment systems must be designed to minimise rainfall collection within the system
Implementation Strategy	<ul style="list-style-type: none"> Spill control procedures will be prepared and personnel trained Dangerous goods will be stored and handled as per the requirements of relevant Australian Standards Areas where contaminants or wastes are stored or handled will be minimised or roofed Dangerous goods will, where appropriate (e.g. outside locations), be stored in bunded areas away from watercourses Stormwater will be diverted around disturbed areas and areas where contaminants or wastes are stored or handled All explosives, hazardous chemicals, corrosive substances, toxic substances, gases and dangerous goods must be stored and handled in accordance with the relevant Australian Standard Explosives will be stored in magazines constructed and located as prescribed in AS 2187

Item	Detail
	<ul style="list-style-type: none"> • Where no Australian Standard is available, any liquid with potential to harm the environment must be <ul style="list-style-type: none"> – Stored in impervious bunded tanks with bunded capacity at least 110% of a single storage tank or 100% of the largest storage tank plus 10% of the second largest storage tank in multiple storage areas – Impervious drum storage must have a bunded capacity to contain at least 25% of the maximum design storage volume within the bund • Stormwater runoff and rainfall events will be collected, treated, reused or released in accordance with environmental and legal requirements • Material safety data sheets for chemicals and dangerous goods will be available on-site • Waste dangerous goods, which cannot be recycled, will be transported to a designated disposal site as approved by the local authority • Any spillage of hazardous waste or other contaminants that may cause environmental harm will be effectively contained and cleaned up as quickly as practicable. Such spillage must not be cleaned up by hosing, or otherwise thereby releasing such waste or contaminants to any land or waters • Spillages must be cleaned up using dry methods that minimise the release of wastes, contaminants or materials to any stormwater drainage system, roadside gutter or waters • Spills of dangerous goods will be rendered harmless and collected for treatment and disposal at a designated site, including cleaning materials, absorbents and contaminated soils • Hydrocarbon spillage from storage areas, diesel and chemical spills from construction equipment, and industrial waste spill will be contained, reported, and treated/remediated in accordance with appropriate legislative and regulatory agency requirements. Drainage will be reinstated • Absorbent and containment material (e.g. absorbent matting) will be available where hazardous materials are used and stored and personnel trained in their correct use • Protective clothing, appropriate to the materials in use, will be provided • Relevant permits will be held and conditions of permits met • Servicing of equipment/machinery will not be permitted on the RoW without prior authorisation from GLNG Operations. All planned services for all equipment is to occur in an approved workshop
Performance indicators	<ul style="list-style-type: none"> • The environment is not being contaminated by hazardous goods • Correct and appropriate storage and handling procedures are in place • Chemicals are stored in secure areas • Collection of rainfall is minimised in all containment systems

14. Water

14.1 Chapter summary

This chapter provides a summary of the existing environmental values and an assessment of the potential surface water and groundwater impacts resulting from the construction and operation of the Mainland GTP. This chapter also outlines the potential mitigation measures and management strategies for the protection of the existing water related environmental values.

14.1.1 Summary of existing water values:

- The Mainland GTP passes through two River Basins; the Calliope and Fitzroy (Dawson sub-catchment, Central Highlands sub-catchment and Boyne-Calliope sub-catchment). The major rivers within the study area include the Calliope River and Dawson River
- An assessment of the general environmental values of the Fitzroy Basin concluded that it comprises of slightly to moderately disturbed aquatic habitat with an overall high ecological value
- The Comet and Dawson sub-catchments are known to contain habitat that supports conservation significant aquatic species such as the 'vulnerable' Fitzroy River turtle, the White-throated snapping turtle and the 'iconic' Platypus
- The Comet River sub-catchment is known to contain habitat for conservation significant species such as the White-throated snapping turtle and Platypus
- The Mainland GTP RoW traverses a number of freshwater waterways and wetland ecosystems (refer Table 14.1)
- Figure 14.3 provides a summary of the watercourses intersected by the Mainland GTP RoW based on watercourse stream orders
- Named watercourses intersected by the Project from west to east from KP0 to KP400 have been assessed and detailed in Section 14.2
- The watercourses with the highest flows are the Dawson River and Calliope River, with little flow occurring in Bell Creek
- The Mainland GTP RoW does not intersect any declared catchments as defined under the *Water Act 2000*
- Nearby surface water monitoring results indicate that Total Nitrogen (TN) and Total Phosphorous (TP) exceed the water quality objectives of the Queensland Water Quality Guidelines 2009 (QWQG) in the majority of watercourses sampled. Dissolved oxygen (DO) is low for a number of the watercourses
- There are 21 Wetland Systems located within the vicinity of the GTP RoW
- There are no Ramsar wetlands listed in proximity to the Mainland GTP RoW
- A high level assessment of large scale groundwater resources was undertaken along the Mainland GTP RoW. The results indicated that groundwater quality is poor with very high conductivity levels

14.1.2 Summary of potential impacts

Construction

The construction of the Mainland GTP has the potential to impact on water related environmental values including increased erosion and sediment movement, decreased surface water and groundwater quality due to chemical pollutants, changes to surface water flow and groundwater hydraulic characteristics, and deterioration in local water supply. In particular, soil erosion and sediment presents a slightly higher risk due to the moderate to high erosion potential of the soils within the Mainland GTP RoW. However, with the implementation of the ESCP (refer Appendix A) and the mitigation measures presented in Chapter 7, it is considered that the impacts associated with soil erosion and sediment are low and manageable.

The impacts to surface water and groundwater quality as a result of chemical pollution are also considered to be low and manageable as chemicals will be stored in accordance with the Waste MP (refer Appendix F), hydrotest water will be treated to the approved water quality discharge limits and sewage will be treated to the relevant standards. Hydrotest water will also be reused (where possible) during the hydrotesting process to minimise impacts on local water supply.

Operation

Regular inspections will be carried out along the Mainland GTP RoW by vehicle and foot patrols to assess the condition of the GTP and associated infrastructure. Maintenance will typically be carried out by small maintenance crews in light vehicles on an annual basis, or as and when required.

It is considered that surface water quality impacts from operational activities are low and manageable due to the infrequent maintenance activities and vehicle movements during rainfall events. There are no anticipated groundwater impacts resulting from operational activities due to the shallow nature of the works.

Furthermore, all works associated with these operational activities will be undertaken in accordance with the Operational Management Plan (OMP) which will be developed prior to construction and implemented in all stages of the Project, including construction, operation and decommissioning.

14.1.3 Summary of proposed mitigation measures for water management

Table 14.1 Environmental protection commitments, objectives and control strategies for water

Item	Detail
Environmental protection objective	<ul style="list-style-type: none"> To minimise the potential impacts associated with erosion, prevent the release of contaminants that may adversely affect downstream surface water quality, and protect the quality of the existing groundwater resources
Specific objectives	<ul style="list-style-type: none"> Prevention of direct or indirect release of contaminants to surface waters Minimisation of incidences of accelerated erosion as a result of construction activities Groundwater quality will not be impacted by development activities Spill containment facilities constructed in accordance with AS 1940 (2004) and AS 3780 (1994) Environmental impacts are within authorised limits
Implementation strategy	Refer to Table 14.11 for water values management control strategies to be implemented during pre-construction, construction and operation of the Mainland EMP
Performance indicators	<ul style="list-style-type: none"> No direct or indirect release of contaminants to surface waters Minimisation of incidences of accelerated erosion as a result of construction activities Groundwater quality is not impacted by development activities Spill containment facilities are constructed in accordance with AS 1940 (2004) and AS 3780 (1994) Environmental impacts are within authorised limits

14.2 Existing surface water and groundwater characteristics

14.2.1 Surface water

The Mainland GTP passes through two River Basins; the Calliope and Fitzroy. The major rivers within the study area include the Calliope River and Dawson River. Other tributaries within the study area include the Larcom, Bell, Kroombit, Banana, Kianga, Callide, Mimosa, Conciliation, Clematis, Hutton and Baffle Creeks. Figure 14.1 (1 of 3) illustrate the watercourses (of stream order¹ 3 and greater) found within the study area that the GTP will traverse.

The majority of the Mainland GTP RoW lies within the Boyne-Calliope and Dawson Sub-regions of the Fitzroy Basin. Water resources in the Fitzroy Basin have a number of important uses including farming, grazing, mining, recreation and urban activities. The remaining eastern end of the Mainland GTP RoW lies within the Calliope River Basin. Cattle grazing, confined to the coastal plains is the main land use in the area, with the northern reaches of the basin remaining densely vegetated. Figure 14.2 illustrates the river basin boundaries.

¹ Stream order is typically a representation of stream size and is a numerical ordering system of each stream section based on its position in a catchment. Small streams that commence in the catchment headwaters are considered first order streams, and as they connect with other streams further down the catchment, they progressively get larger and become higher order streams.

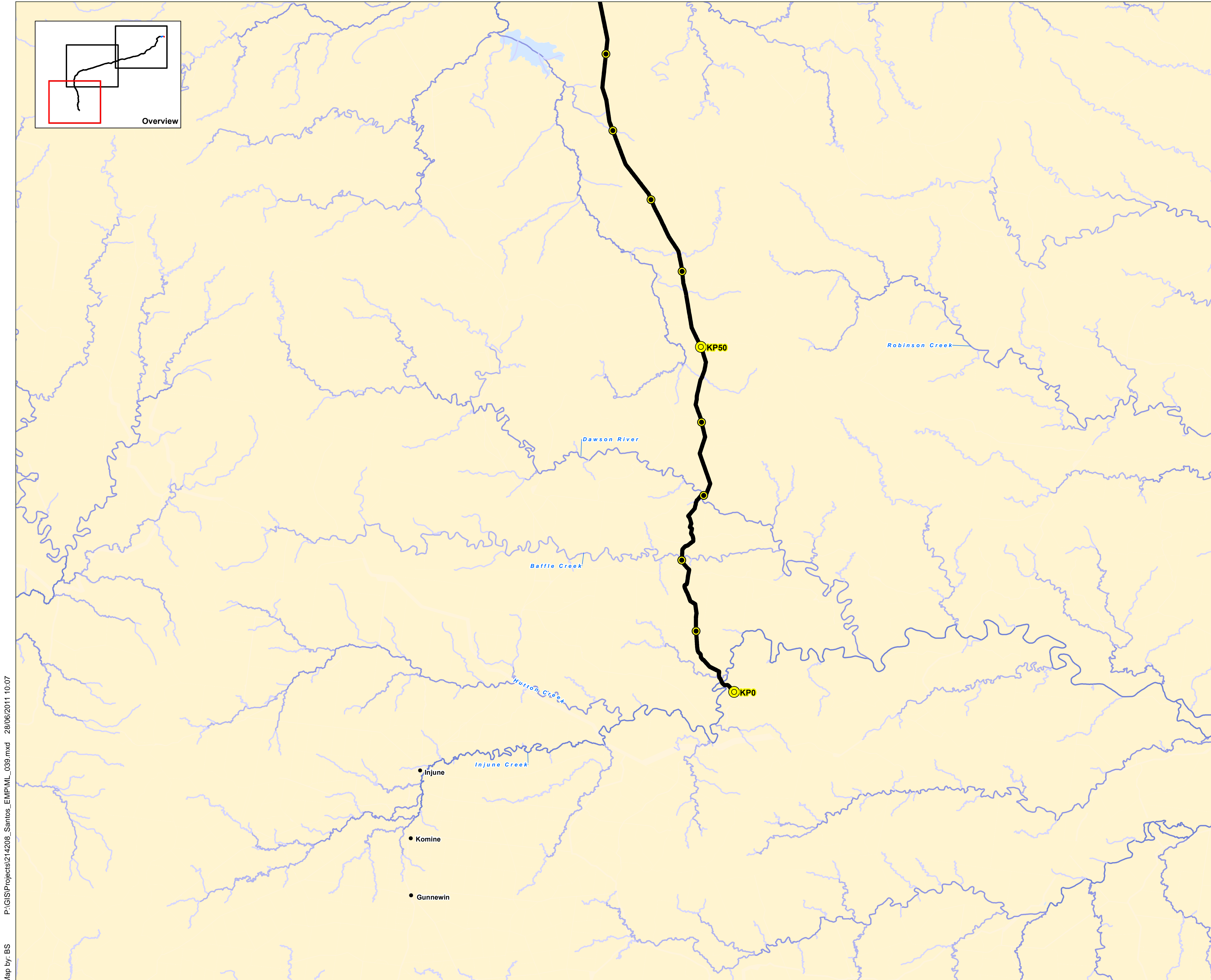


Mainland GTP EM Plan

- Gas Transmission Pipeline (GTP)
- Mainland GTP EM Plan
 - Marine Crossing GTP EM Plan
 - Curtis Island GTP EM Plan

- Kilometre Post Distance Marker
- 50km
 - 10km

- Watercourses Stream Order
- 3
 - 4
 - 5
 - 6
 - 7
 - 8
 - 9

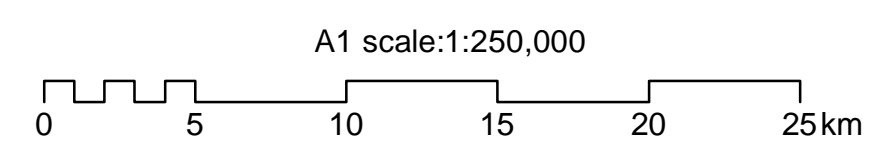
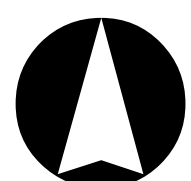


Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Watercourses: Department of Environment and Resource
 Management, 2009.

Watercourses
Figure 14.1 (Page 1 of 3)

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Map by: BS



GLNG No: 3381-40-0426
 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

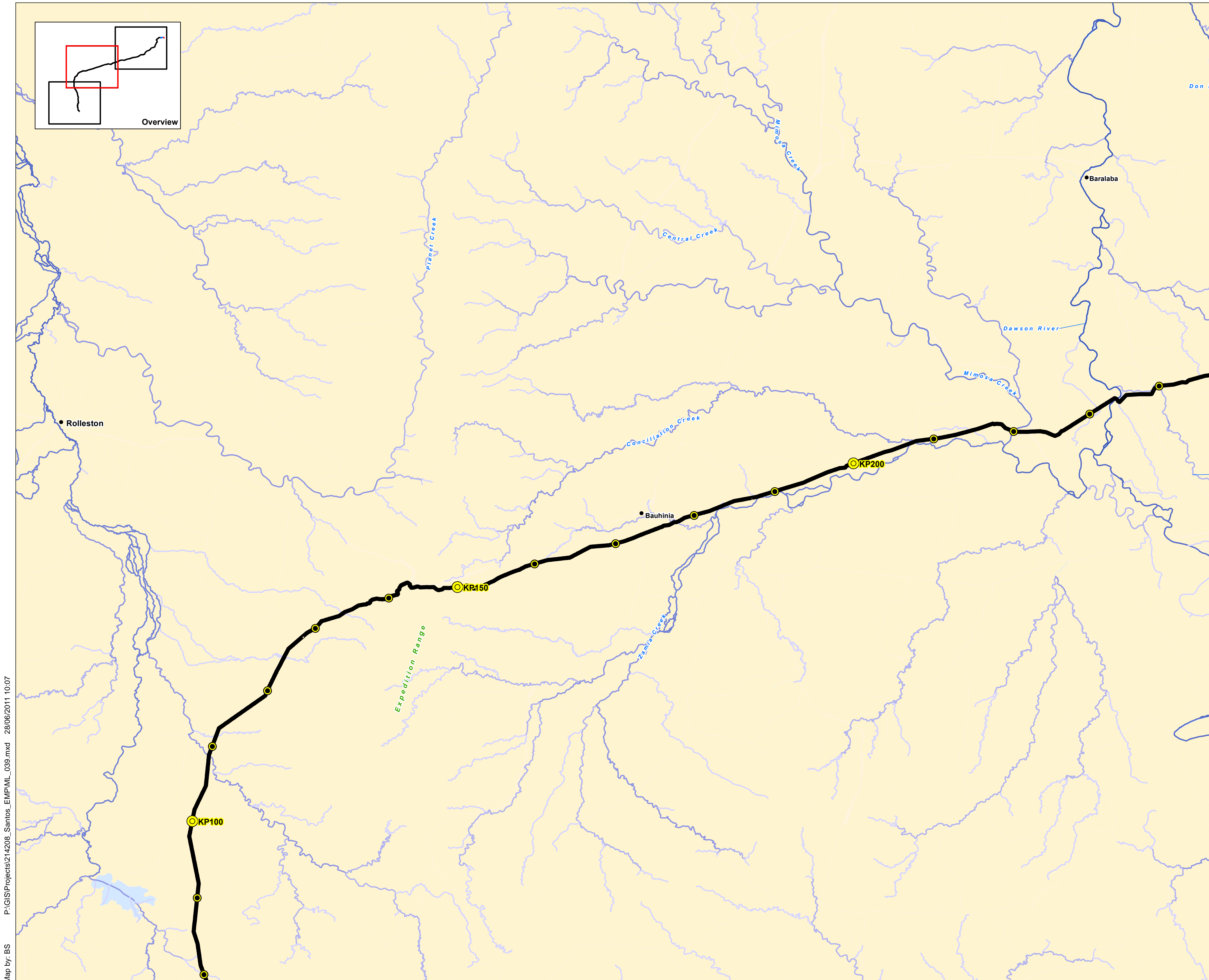
- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 50km
- 10km

Watercourses Stream Order

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- 5
- 6
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- 8
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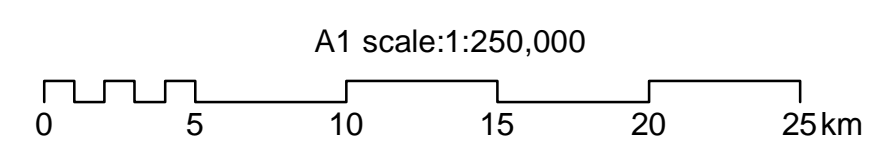
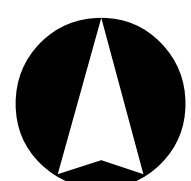


Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Watercourses: Department of Environment and Resource Management, 2009.

Watercourses
Figure 14.1 (Page 2 of 3)

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Map by: BS





Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

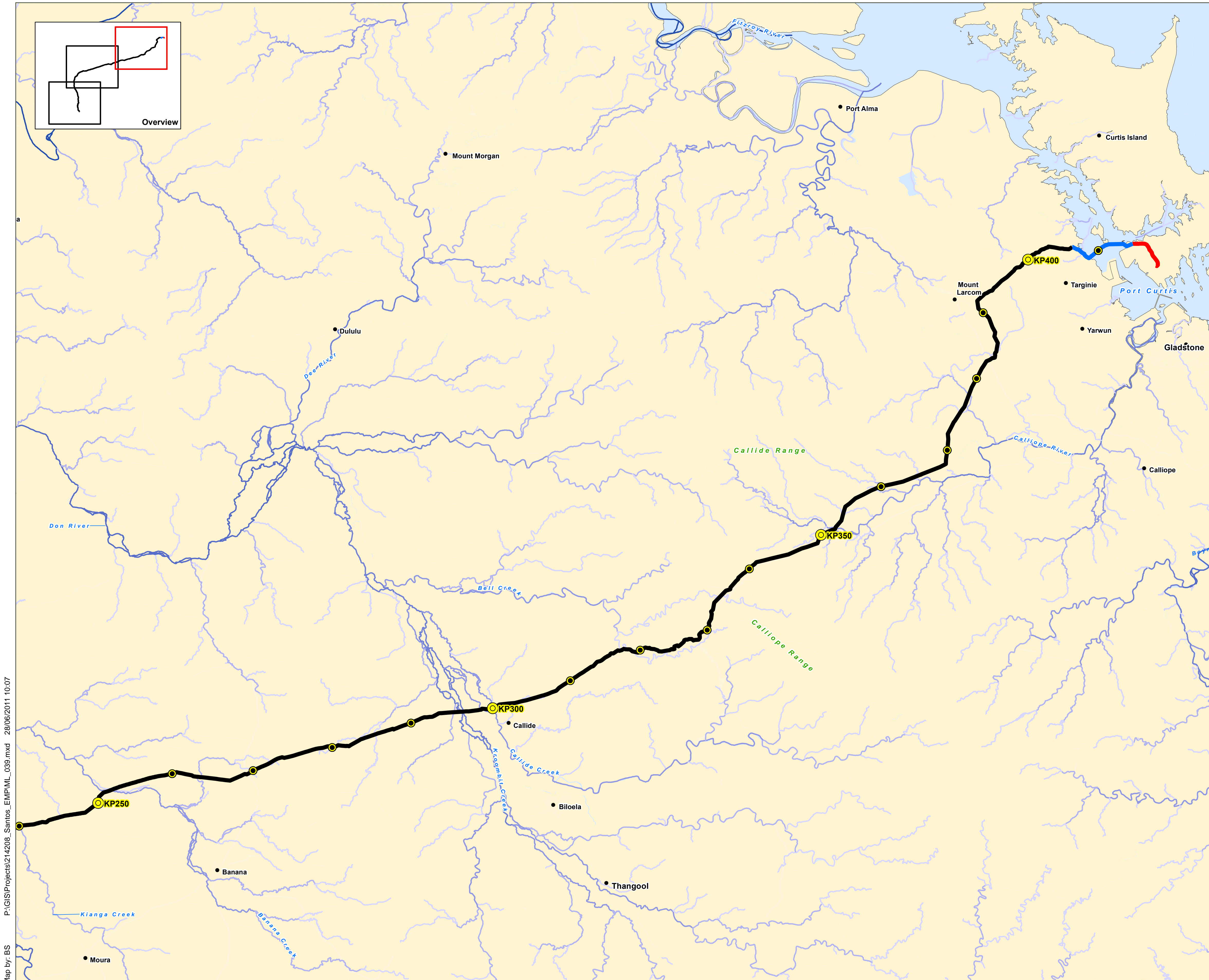
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Kilometre Post Distance Marker

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Watercourses Stream Order

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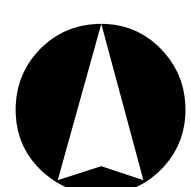


Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Watercourses: Department of Environment and Resource Management, 2009.

Watercourses
Figure 14.1 (Page 3 of 3)

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Map by: BS



A1 scale: 1:250,000
 0 5 10 15 20 25km

GLNG No: 3381-40-0426
 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 50km
- 10km

Drainage Basin Area along GTP ROW

- Calliope
- Fitzroy
- Curtis Island

Drainage Basin Sub-Area along GTP ROW

- Boyne-Calliope Sub-Catchment
- Central Highlands Sub-Catchment
- Curtis Island Sub-Catchment
- Dawson Sub-Catchment
- Fitzroy River Sub-Catchment

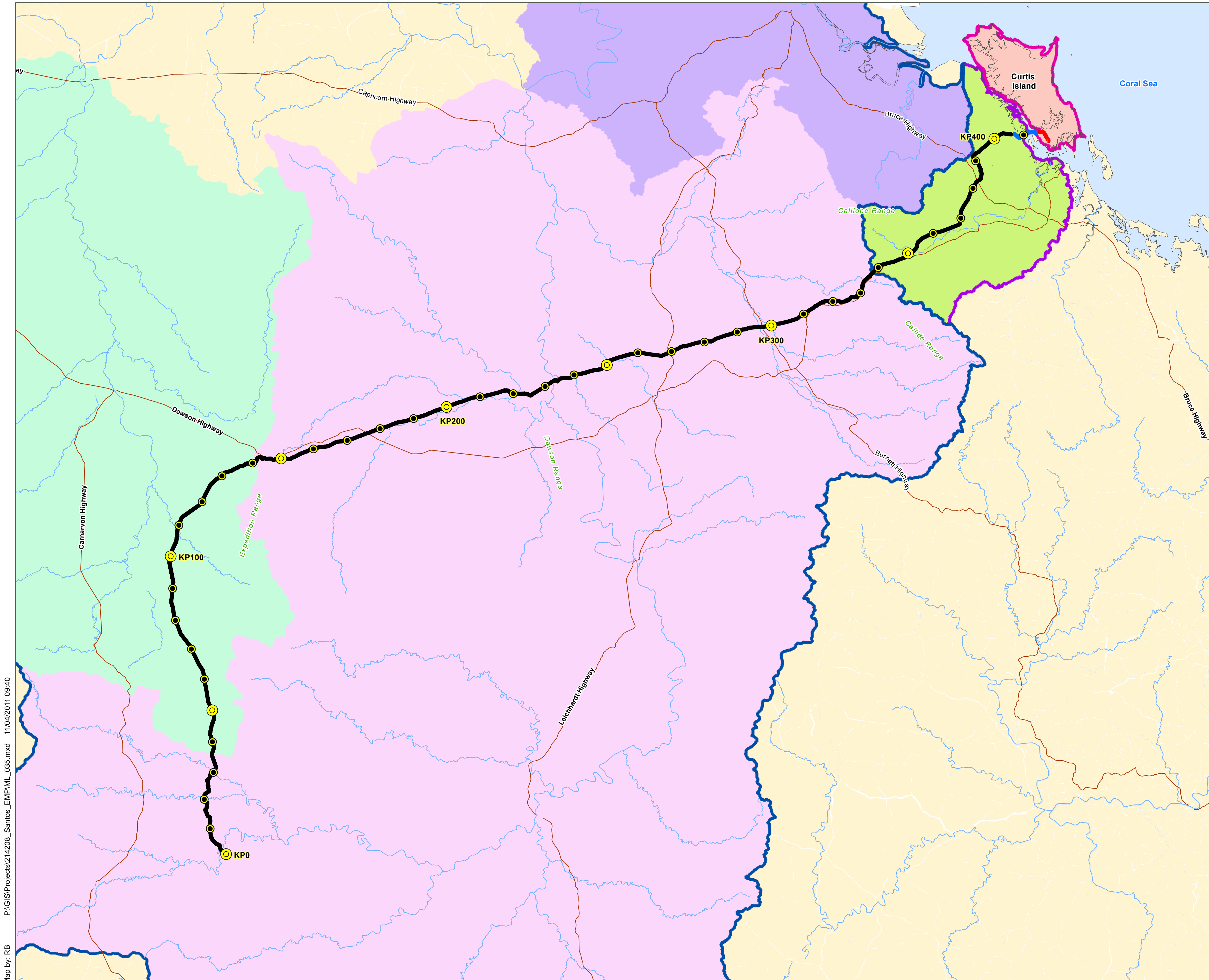
- Watercourse
- Major Road

Source:
Gas Transmission Pipeline (GTP): Santos, Jan 2011.
Drainage Basin Areas and Sub-Areas: Department of Natural Resources and Water, 2007.

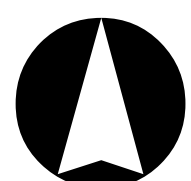
Drainage Basin Areas Figure 14.2

Date: 11/04/2011

Version: b



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 Map by: RB



A1 scale: 1:600,000
 0 10 20 30 40 50km

GLNG No: 3381-40-0427
 Coordinate system: GCS_GDA_1994

Water Resource Plans

Water Resources Plans exist for the two River Basins located within the Project area, these being the Water Resource (Calliope River Basin) Plan 2006 and the Water Resource (Fitzroy River Basin) Plan 1999. The Water Resources Plans provide environmental values for the waterways located within each River Basin which must be protected.

Description of catchments

The Project occurs within the Fitzroy Basin (Dawson sub-catchment, Central Highlands sub-catchment and Boyne-Calliope sub-catchment).

The Fitzroy Basin is considered the largest basin on Australia's east coast (156,000 km²), and is characterised by large variations in river flows. Rainfall within the Fitzroy Basin typically occurs during October to April, resulting in predominately summer stream flows. The ephemeral nature of many of the watercourses within the Fitzroy Basin is a result of the prolonged dry periods during the winter months. This is consistent with the findings of the aquatic assessment conducted as part of the EIS (URS 2009).

An assessment of the general environmental values of the Fitzroy Basin concluded that it comprises slightly to moderately disturbed aquatic habitat. Where assessed within the Project footprint as part of the EIS, the Fitzroy Basin is considered to possess aquatic habitat with an overall high ecological value (URS 2009).

The following sections outline the characteristics of the sub-catchments in which the Mainland GTP RoW is located.

Dawson sub-catchment

The Dawson sub-catchment of the Fitzroy Basin comprises approximately 50,800 km² of land, encompassing the major Dawson River, Don River and associated tributaries. The sub-catchment is bounded by the Auburn, Calliope, Ulam, and Dee Ranges to the east, Lynd and Expedition Ranges to the west and the Great Dividing Range to the south and southwest.

As a result of the low gradient of the sub-catchment, tributaries of the Dawson River are typically characterised by long, winding, upper and middle reaches. Headwaters typically flow through relatively narrow valleys and gorges. The flow pattern is generally from south to north direction (URS 2009).

According to the State of the Rivers Report (Department of Planning and Infrastructure (DPI) 1995), streambank erosion occurs typically downstream of road crossings, where appropriate battering and stabilising works have not been undertaken or maintained. Furthermore, streambank erosion is common where overgrazing of the stream bed and banks have occurred, and where bank scouring has occurred as a result of runoff from nearby cattle pads. An examination of the overall condition rating for the Dawson sub-catchment concluded that the majority of the sub-catchment is considered to exhibit a moderate condition.

Specifically, the State of the Rivers Report (DPI 1995) found:

- Widespread degradation of the riparian zone, resulting from clearing of natural vegetation, the invasion of exotic species, and generally high disturbance levels in the reach environs
- Aquatic habitats in generally poor condition due to low levels of instream and overhanging stream cover, low diversity of instream habitat attributes in most stream beds, and generally low diversity of channel habitat types
- Relatively stable banks throughout the catchment, displaying moderate to low susceptibility to the dominant process of erosion
- Relatively stable beds and bars throughout the catchment, although aggradation processes were dominant at more than half the sites surveyed
- A number of sites identified with significant conservation values
- Most stream lengths surveyed within the catchment described as being in moderate to poor overall condition

- Grazing activities identified as the most common detrimental influence impacting upon stream and riparian attributes

The Dawson sub-catchment is known to contain habitat that supports conservation significant aquatic species such as the 'vulnerable' Fitzroy River turtle (listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)), the White-throated snapping turtle (which although listed as Least Concern under the *Nature Conservation Act 1992* (NC Act), has been identified by the Department of Environment and Resource Management (DERM) as 'high priority for conservation'), and the NC Act listed 'iconic' Platypus. Further details regarding aquatic flora and fauna are provided in Chapter 9.

Central Highlands sub-catchment

The Mainland GTP RoW bisects the south-eastern corner of what is mapped as the Central Highlands sub-catchment. This sub-catchment comprises approximately 44,798 km² of land, and encompasses the Nogoia and Comet Rivers and the associated tributaries, in addition to Lake Maraboon and Lake Nuga Nuga (URS 2009).

The Central Highland sub-catchment is bound by the Expedition Range and the townships of Tieri and Comet to the east, the Blair Athol State Forest to the north, and Zamia State Forest in the west.

According to the State of the Rivers Report for the Comet, Nogoia and Mackenzie Rivers (DPI 2000), very few watercourses within the Central Highlands sub-catchment are in good condition, most having been subjected to high levels of disturbance. High levels of erosion and siltation is common within the sub-catchment, and much of the riparian vegetation has typically been cleared. Furthermore, exotic species are common, and aquatic habitat is considered to be typically poor.

Despite this, the Central Highlands sub-catchment is known to contain habitat for conservation significant species such as the White-throated snapping turtle (particularly within the Comet River system), and Platypus. It is understood that the Fitzroy River turtle has not been recorded within the Central Highlands sub-catchment. However, should it be discovered within this region, it is expected that its distribution is likely to be restricted to the faster flowing waters of the main rivers, and to reaches in relative proximity to potential nesting habitat. Further details regarding aquatic flora and fauna are provided in Chapter 9.

Boyne-Calliope sub-catchment

The north-eastern segment of the Mainland GTP RoW bisects the Boyne-Calliope sub-catchment. This sub-catchment comprises an area of approximately 2,236 km², and encompasses the Calliope River and its tributaries.

The Boyne-Calliope sub-catchment is bound by the Pacific Ocean to the east and north. Arthurs Seat State Forest forms the south-eastern boundary, whilst Bulburin National Park, Kalpowar and Borilla State Forests mark the approximate southern extremity of the sub-catchment. The Boyne-Calliope sub-catchment is bound by Calliope Range State Forest and the Dawson sub-catchment area to the west.

Current water quality conditions within the Boyne-Calliope sub-catchment are influenced by a number of anthropogenic activities, including grazing, agriculture, industry and urban-based activities. Based on the extent of catchment clearing and existing land use patterns, the condition of the Boyne-Calliope sub-catchment was reported as poor to moderate in the 1992 National Land and Water Audit (C & R Consulting 2005).

The Fitzroy River turtle is not expected to occur within the Boyne-Calliope sub-catchment as this is typically outside of its natural distribution. However, the Platypus is known within the Boyne-Calliope sub-catchment and the White-throated snapping turtle has been identified in the surrounding catchments including Raglan. Therefore these species are considered as part of this assessment. Further details regarding aquatic flora and fauna are provided in Chapter 9.

Freshwater waterways and wetlands

The Mainland GTP RoW traverses a number of freshwater waterways and wetland ecosystems. Table 14.2 provides a summary of the watercourses intersected by the Mainland GTP RoW based on watercourse stream orders.

Table 14.2 Stream order crossings

Stream order	Number of crossings
1	93
2	42
3	28
4	8
5	7
6	4
7	0
8	1
9	0

Named watercourses intersected by the Project from west to east from KP0 to KP400 include:

- Alarm Creek
- Back Creek
- Baffle Creek
- Banana Creek
- Bell Creek
- Brolga Gully
- Bully Frog Creek
- Callide Creek
- Callide Creek (old Channel)
- Calliope River
- Christmas Creek
- Clematis Creek
- Collards Creek
- Conciliation Creek
- Dawson River
- Deep Creek
- Denby Creek
- Gravel Creek
- Harper Creek
- Hutton Creek
- Ironbark Creek
- Kianga Creek
- Kroombit Creek
- Larcom Creek
- May Creek
- Mimosa Creek
- Neville Creek
- Police Camp Creek
- Prospect Creek
- Sellheim Creek

The following sections provide an assessment of the aquatic values for the aforementioned watercourses and wetlands that possess a stream order value equal to or greater than 3. This includes an additional 12 unnamed ephemeral tributaries (stream order greater than 3) traversed by

the Mainland GTP RoW. For ease of reference, waterway crossings have been assessed and presented below in the order of which the pipeline traverses, beginning in the southwest (ie Fairview CSG Fields).

It is considered that the minor ephemeral tributaries and drainage lines (particularly those with stream orders 1 and 2, ie flow paths which begin at the top of a catchment) possess very limited aquatic value. These tributaries generally do not possess permanent pools, and have typically been cleared resulting in an approximate riparian zone width of 0 m to 20 m, and lack aquatic vegetation. Thus, no further aquatic values assessment was conducted on such watercourses.

Figure 14.3 indicates the locations of each stream crossing of the Mainland GTP.

Hutton Creek

Hutton Creek is a tributary of Dawson River, and may be described as a typical ephemeral riverine system within permanent pools.

The DERM designated wetland Boggomoss Springs² also lies in the upstream catchment of the Dawson River. Flows from the upper Dawson River, including Baffle Creek, Sardine Creek, Dawson River (downstream) and Hutton Creek feed into the wetland.

Historic and current land uses have potentially impacted on the environmental value of the Hutton Creek system, with the floodplain significantly cleared for grazing. However, the system is likely to be in moderate to good health due in part to the baseline flows and the relatively intact and continuous riparian zone.

The Mainland GTP RoW intersects the mid reach of Hutton Creek, where the riparian zone consists primarily of *Casuarina cunninghamiana*, *Melaleuca viminalis*, with emergent *Eucalyptus tereticornis* (Photograph 14.1). However, within some parts the riparian zone has been reduced with the majority of some areas cleared to the high water bank (ie an area upstream and downstream of the Mainland GTP RoW).

As with other creek systems within the region, the waters are highly turbid reducing visibility and macrophyte growth. Despite this, it is possible that populations of the White-throated snapping turtle and Fitzroy River turtle may occur within the vicinity of this creek crossing. Previous studies conducted (Hamann *et al* 2007) have identified this species from the headwaters of Hutton Creek (ie to the west of the proposed crossing) and downstream near the junction of Hutton Creek and Boyd Creek (ie to the east of the proposed crossing). Furthermore, it is considered possible that the Fitzroy River turtle also occurs within Hutton Creek.

Previous site investigations of the Hutton Creek crossing conducted by Aurecon (2009) concluded that this section of the creek is likely to support a stable population of Platypus as a result of the creek geomorphology and linkage to a major riverine ecosystem in the Dawson River.

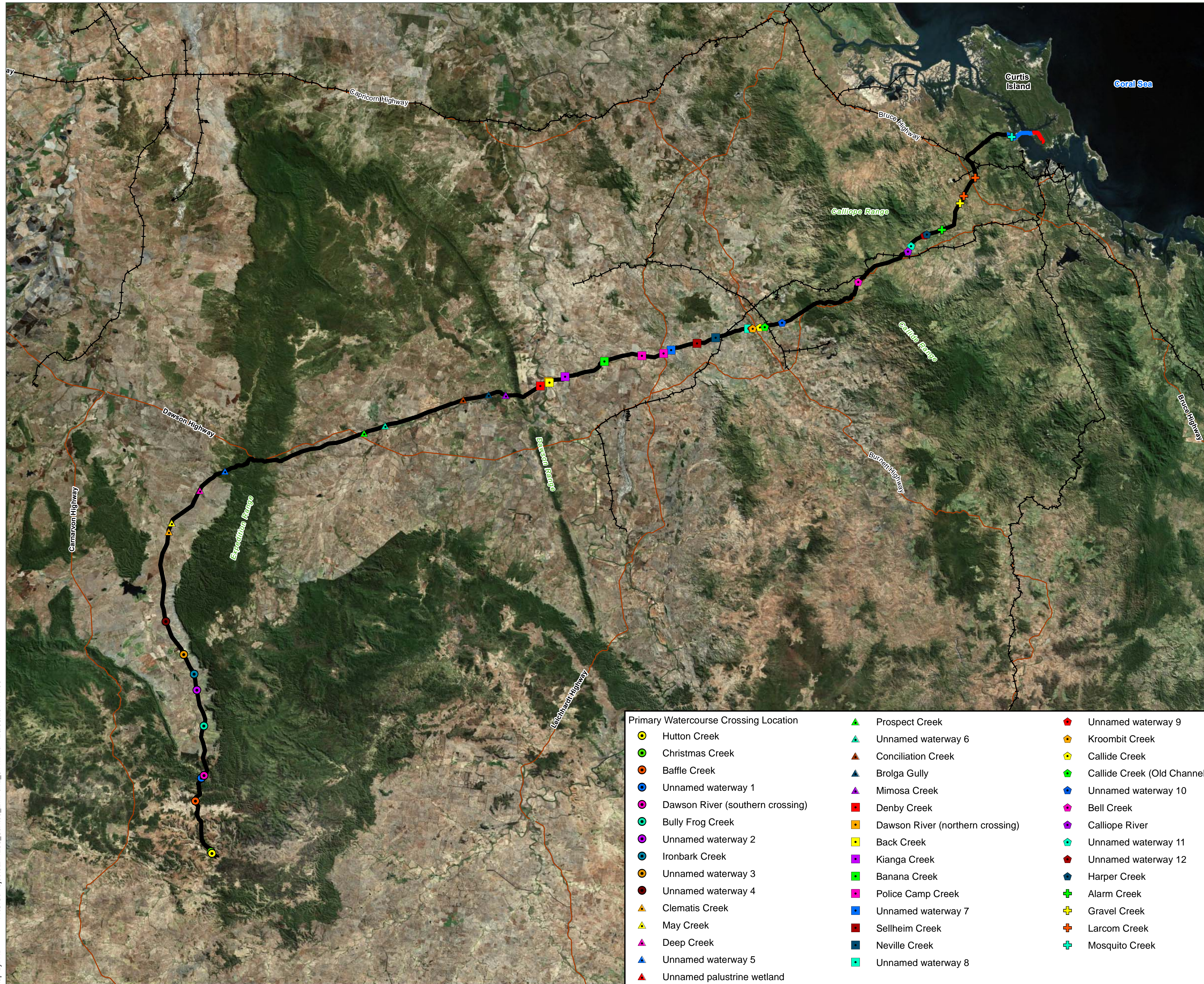
² Designated by DERM as a Nationally Important Wetland.



Mainland GTP EM Plan

- Gas Transmission Pipeline (GTP)
- Mainland GTP EM Plan
 - Marine Crossing GTP EM Plan
 - Curtis Island GTP EM Plan
 - Rail
 - Major road

Note: See inset for Primary Watercourse Crossing legend.

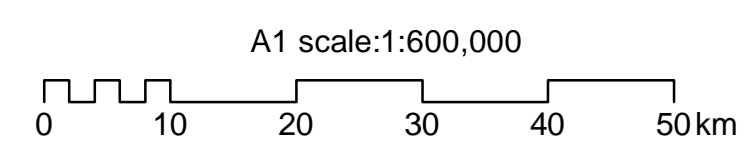
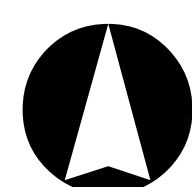


Primary Watercourse Crossing Location					
	Hutton Creek		Prospect Creek		Unnamed waterway 9
	Christmas Creek		Unnamed waterway 6		Kroombit Creek
	Baffle Creek		Conciliation Creek		Callide Creek
	Unnamed waterway 1		Brolga Gully		Callide Creek (Old Channel)
	Dawson River (southern crossing)		Mimosa Creek		Unnamed waterway 10
	Bully Frog Creek		Denby Creek		Bell Creek
	Unnamed waterway 2		Dawson River (northern crossing)		Calliope River
	Ironbark Creek		Back Creek		Unnamed waterway 11
	Unnamed waterway 3		Kianga Creek		Unnamed waterway 12
	Unnamed waterway 4		Banana Creek		Harper Creek
	Clematis Creek		Police Camp Creek		Alarm Creek
	May Creek		Unnamed waterway 7		Gravel Creek
	Deep Creek		Sellheim Creek		Larcom Creek
	Unnamed waterway 5		Neville Creek		Mosquito Creek
	Unnamed palustrine wetland		Unnamed waterway 8		

Source:
Gas Transmission Pipeline (GTP): Santos, Jan 2011.
Aerial: BING, 2011.

Primary Watercourse Crossing Locations Figure 14.3

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Map by: RB



GLNG No: 3381-40-0428
Coordinate system: GCS_GDA_1994

Date: 28/06/2011

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Photograph 14.1 Mainland GTP RoW crossing location on Hutton Creek

Christmas Creek

Christmas Creek (Photograph 14.2) is a formed tributary of Hutton Creek, located within the Project's south. As with most other creeks within the Dawson River system, Christmas Creek is considered ephemeral with waters that are highly turbid, reducing visibility and macrophyte growth.

Historic and current land uses have potentially impacted on the environmental value of the Christmas Creek system, with the floodplain significantly cleared for grazing. However, the system is likely to be in moderate health due in part to the baseline flows and the relatively intact and continuous riparian zone.

The Mainland GTP RoW bisects the lower reach of Christmas Creek (stream order 4), near the Hutton Creek junction, where the aquatic value is considered poor. The existing riparian vegetation at the proposed crossing point has been previously cleared (90 m) to accommodate the existing gas and water pipelines. Cattle have also had an adverse impact on the ecosystem health. The Mainland GTP RoW has been positioned alongside an existing pipeline and will bisect the waterway on a perpendicular angle, thus minimising the amount of clearing necessary within the riparian zone.

Ecological investigations of the Christmas Creek/Hutton Creek junction (Aurecon 2009) conducted previously indicate that the upstream segment of Christmas Creek is likely to support a stable population of Platypus as a result of the creek geomorphology and linkage to a major riverine ecosystem in the Dawson River. However, where the Mainland GTP RoW bisects Christmas Creek, it is considered that no suitable permanent habitat for this species exists, as a result of the ephemeral nature of the creek.

The Christmas Creek crossing is considered unlikely to support the Fitzroy River turtle or the White-throated snapping turtle, particularly during the Spring nesting season, as water is not a permanent feature.



Photograph 14.2 Location of the Mainland GTP RoW crossing on Christmas Creek

Baffle Creek

Baffle Creek (Photograph 14.3) is a tributary of the Dawson River and is located within the southern region of the proposed GTP ROW (approximately 18 km from the southern terminus of the GTP). Flows from the upper Dawson River, including Baffle Creek, Dawson River (downstream) and Hutton Creek feed into the nearby Boggomoss Springs wetland.

The local Baffle Creek catchment has been highly modified (particularly along the southern region), as a result of agricultural land use (ie grazing). Along the northern periphery of Baffle Creek, trailing and riparian vegetation is considered dense.

The Mainland GTP RoW bisects the mid reach of Baffle Creek, where DERM mapping (2010)³ classifies it as a stream order 4. Baffle Creek is of high ecological value within the vicinity of the Mainland GTP RoW.

Baffle Creek is unique in that the mid and lower reaches of the watercourse are located in a canyon with steep sandstone cliffs. The cliffs within the vicinity of the Mainland GTP RoW have good trailing vegetation on either side (approximately 500 m in width).

The riparian zone is primarily *Melaleuca viminalis* along the active channel, with a diverse array of vegetation, including eucalypts and rainforest and other vine thicket species between the active channel and the cliff faces. Stream diversity is high with riffles and pool habitats, with instream complexity also high due to the presence of fallen timber, over hanging vegetation, exposed banks and cuttings, heterogeneous substrates and large boulders. It is likely that this area is an important refuge habitat for aquatic and terrestrial fauna during the dry season.

Baffle Creek is considered likely to support the Fitzroy River turtle or the White-throated snapping turtle, where permanent pools exist during the drier months. Previous studies conducted (Hamann et al 2007) have identified the White-throated snapping turtle as occurring within the Dawson River, to the north-west and east of the Baffle Creek crossing. The Fitzroy River turtle is known within the Dawson River system (DERM 2010a), and is considered a possible resident within this creek. Baffle Creek is also likely to support a stable population of Platypus as a result of the creek geomorphology (ie canyon) and linkage to a major riverine ecosystem in the Dawson River.

³ From DERM dataset: *Queensland Other Watercourses – Version 2.0*



Photograph 14.3 Looking upstream along Baffle Creek towards the Mainland GTP RoW

Unnamed waterway 1

This unnamed watercourse is a tributary of the Dawson River, located within the southern region of the Mainland GTP RoW (approximately 25 km from the southern terminus of the pipeline). As with most other watercourses within the region, this watercourse is considered ephemeral.

The Mainland GTP RoW bisects the lower reach of this unnamed watercourse, where it is classified by DERM as a stream order 3.

Review of recent aerial photographs of the proposed crossing reveals that riparian vegetation within the vicinity has been subjected to historical clearing. However, trailing vegetation within the surrounding areas is considered largely intact, likely as a result of the terrain (Photograph 14.4). The proposed Mainland GTP RoW will bisect the waterway on a perpendicular angle, thus minimising the amount of clearing necessary within the riparian zone.

Despite its close proximity to the Dawson River, this unnamed waterway is considered unlikely to support the Fitzroy River turtle or the White-throated snapping turtle as a result of its ephemeral nature and the sloping geology that prevents permanent pools from forming. It is also unlikely that suitable habitat exists for platypus. No breeding places for aquatic fauna are expected to occur within close proximity to the Mainland GTP RoW crossing point.



Photograph 14.4 Looking north towards unnamed watercourse 1

Dawson River (southern)

The Dawson River extends approximately 781 km, commencing at the junction of the Mackenzie and Fitzroy Rivers in the north of the Dawson River Catchment, continuing in a southern and subsequent western direction.

The DERM designated wetland Boggomoss Springs also lies in the upstream catchment of the Dawson River. Flows from the upper Dawson River, including Baffle Creek, Dawson River (downstream) and Hutton Creek feed into the wetland.

The local Dawson River catchment has been heavily cleared as a result of mixed agricultural land use (ie grazing and cropping). As a result, the River is largely devoid of trailing vegetation, particularly within the mid and lower reaches (where it joins the Mackenzie and Fitzroy Rivers). The riparian vegetation along the Dawson River, particularly within the mid and lower reaches is considered typically fragmented as a result of historical clearing, land use and edge effects.

The Mainland GTP RoW bisects the mid reach of the Dawson River, where DERM mapping (2010) indicates it is a stream order 5.

The State of the Rivers report (DPI 1995) indicates that the Dawson River (southern) crossing exhibits very poor channel diversity (less than 20%), very good riparian vegetation condition (greater than 80%), and good aquatic habitat condition (60-80%).

The area where the Mainland GTP RoW crosses the Dawson River has been cleared for a road. The active channel is less than five metres while the flow channel is grassed and about 30 m wide. Permanent pools are present upstream and downstream of the Mainland GTP RoW. The riparian vegetation is a mix of *Eucalyptus*, *Angophora* and *Allocasuarina* spp., with the trailing vegetation *Eucalyptus populnea* on alluvial plains (Photograph 14.5).

The upper reaches of the Dawson River are considered suitable habitat and are likely to support the Fitzroy River turtle or the White-throated snapping turtle. Previous studies conducted (Hamann *et al*, 2007) have identified the White-throated snapping turtle as occurring within the Dawson River, to the north of this Dawson River crossing. The Fitzroy River turtle is known within the Dawson River system (DERM 2010a), and is thus considered a possible resident within the vicinity of this crossings. The Dawson River is also likely to support a stable population of Platypus as a result of the river geomorphology and permanent water resources.



Photograph 14.5 Dawson River looking downstream from the Mainland GTP RoW

Bully Frog Creek

Bully Frog Creek is located to the north of the Dawson River and to the west of Arcadia Valley Road, within the southern region of the Mainland GTP RoW in the Central Highlands sub-catchment.

The local Bully Frog Creek catchment has been heavily cleared within the lower and mid reaches, as a result of agricultural land use (ie grazing). As a result, these segments of the watercourse are largely devoid of trailing and riparian vegetation. The upper reaches of this waterway are considered heavily wooded and are associated with Expedition Range.

The Mainland GTP RoW bisects the lower reach of Bully Frog Creek, where DERM mapping (2010) indicates it is a stream order 3.

The riparian vegetation is currently mapped as Brigalow. However, field investigations of the site determined that the vegetation community is non-remnant and is primarily Silver-leafed ironbark with an understory which was pastoral grasses and bare soil. Riparian vegetation within the vicinity of the proposed crossing of Bully Frog Creek is highly disturbed and in poor health as a result of historical land clearing and agricultural activities (Photograph 14.6). Instream complexity and diversity is also poor with the channel being comprised of a homogenous substrate with little to no instream debris.

Despite its close proximity to known habitat for the White-throated snapping turtle and Fitzroy River turtle, the Bully Frog Creek crossing is considered unlikely to permanently support populations of aquatic fauna, as a result of lack of permanent water pools, particularly during the dry season.



Photograph 14.6 Pool on Bully Frog Creek 100 m upstream of the Mainland GTP RoW crossing location

Unnamed waterway 2

This unnamed ephemeral watercourse is a tributary of Arcadia Creek, which runs parallel to the Arcadia Valley Road. The upper reaches of this tributary occurs within the adjacent Expedition Ranges, to the west. This creek is located to the north of Bully Frog Creek in the Central Highlands sub-catchment.

The local waterway catchment has been heavily cleared for agricultural land use (ie grazing) within the lower and mid reaches. As a result, these segments of the watercourse are largely devoid of trailing and riparian vegetation. The upper reaches of this waterway are considered heavily wooded and are associated with Expedition Range.

The Mainland GTP RoW bisects the mid reach of the unnamed watercourse, where DERM mapping (2010) classifies the segment as a stream order 3.

Review of recent aerial photographs revealed that the riparian vegetation associated with this unnamed waterway is highly fragmented, and permanent dams have been constructed both upstream and downstream of the proposed crossing point.

As with most other watercourses within the region, this watercourse is considered ephemeral, in which flow requires heavy rainfall. Thus, no permanent aquatic habitat occurs at this location, and therefore it is unlikely that conservation significant species such as the White-throated snapping turtle, Fitzroy River turtle and Platypus would occur.

Ironbark Creek

Ironbark Creek is an ephemeral watercourse that is bisected by the Mainland GTP RoW to the west of Expedition Range in the Central Highlands sub-catchment.

The local Ironbark Creek catchment has been heavily cleared within the lower and mid reaches, as a result of agricultural land use (ie grazing). As a result, these segments of the watercourse are largely devoid of trailing vegetation and exhibit highly fragmented riparian vegetation. The upper reaches of this waterway are considered heavily wooded and are associated with Expedition Range.

The Mainland GTP RoW bisects the mid reach of Ironbark Creek, between Arcadia Valley Road and Expedition Range. Akin to the majority of the creek, the proposed crossing (stream order 3) exhibits a highly fragmented strip of riparian vegetation, which measures approximately 100 m in width. In order

to minimise the extent of clearing within the riparian zone, the Mainland GTP RoW has been positioned to bisect Ironbark Creek perpendicularly.

Stream diversity and instream complexity are poor, with the active channel having steep sides, homogeneous substrate, no undercuts or overhanging vegetation and the area is predominantly dry. The area has a large flow channel area adjacent to it, with a large palustrine area with *Eucalyptus tereticornis* directly downstream (Photograph 14.7).

Water flow within Ironbark Creek is limited to periods of heavy rainfall. As a result, no permanent habitat exists for aquatic fauna species. During times of peak flow, it is also considered unlikely that this creek provides suitable habitat for conservation significant species including the White-throated snapping turtle, Fitzroy River turtle and Platypus.



Photograph 14.7 Ironbark Creek looking upstream from the Mainland GTP RoW

Unnamed waterway 3

This unnamed ephemeral watercourse is a tributary of the Brown River, which runs parallel to the Arcadia Valley Road and adjoins Lake Nuga Nuga in the north. The upper reaches of this tributary occurs within the adjacent Expedition Ranges, to the west. This unnamed watercourse is located to the north of Ironbark Creek.

The local waterway catchment has been heavily cleared within the lower and mid reaches, as a result of agricultural land use (ie grazing). As a result, these segments of the watercourse are largely devoid of trailing and riparian vegetation. The upper reaches of this waterway are considered heavily wooded and are associated with Expedition Range.

The Mainland GTP RoW bisects the mid reach of the unnamed watercourse, where DERM mapping (2010) classifies the segment as a stream order 4.

Review of recent aerial photographs revealed that the riparian vegetation associated with this unnamed waterway is highly fragmented, and permanent dams have been constructed both upstream and downstream of the proposed crossing point.

As with most other watercourses within the region, this watercourse is considered ephemeral, in which flow requires heavy rainfall. Thus, no permanent aquatic habitat occurs at this location and therefore it is unlikely that conservation significant species such as the White-throated snapping turtle, Fitzroy River turtle and Platypus would occur.

Unnamed waterway 4

This unnamed ephemeral watercourse is a tributary of the Brown River, which runs parallel to the Arcadia Valley Road and adjoins Lake Nuga Nuga in the north. The upper reaches of this tributary occurs within the adjacent Expedition Ranges, to the west. This waterway is located to the north of Unnamed waterway 3.

The local waterway catchment has been heavily cleared for agricultural land use (ie grazing) within the lower and mid reaches. As a result, these segments of the watercourse are largely devoid of trailing and riparian vegetation. The upper reaches of this waterway are considered heavily wooded and are associated with the Expedition Range.

The Mainland GTP RoW bisects the mid reach of the unnamed watercourse, where DERM mapping (2010) classifies the segment as a stream order 3.

Review of recent aerial photographs revealed that the majority of this watercourse is devoid of riparian vegetation, and permanent dams have been constructed both upstream and downstream of the proposed crossing point.

As with most other watercourses within the region, this watercourse is considered ephemeral, in which flow requires heavy rainfall. Thus, no permanent aquatic habitat occurs at this location, and therefore it is unlikely that conservation significant species such as the White-throated snapping turtle, Fitzroy River turtle, and Platypus would occur.

Clematis Creek

Clematis Creek is located to the west of Expedition Ranges and 18 km to the northeast of Lake Nuga Nuga (a DERM mapped lacustrine wetland). As with most other watercourses within the region, Clematis Creek is considered ephemeral.

The local Clematis Creek catchment has been heavily cleared as a result of agricultural land use (ie grazing), particularly within the mid and lower reaches. As a result, the watercourse is largely devoid of trailing vegetation within these regions. Furthermore, the riparian vegetation along mid and lower reaches of Clematis Creek is considered highly fragmented as a result of historical clearing, land use and edge effects. The upper reaches of this creek system are considered heavily wooded, in association with the Expedition Ranges.

The State of the Rivers report (DPI 2000) indicates that this reach of Clematis Creek exhibits very poor channel diversity (less than 20%), very poor aquatic and riparian vegetation, and moderate (40-60%) aquatic habitat.

The Mainland GTP RoW bisects the mid reach of Clematis Creek, where DERM mapping (2010) indicates the reach as a stream order 5. The riparian zone is restricted to the high water bank and has been impacted by cattle, which has resulted in part, in slip erosion along both banks. It is highly likely that any large environmental flows will result in the removal and deposition of the sediments downstream. The riparian zone and banks also have a high proliferation of weeds, including *Parthenium hysterophorus* (Parthenium) and *Argemone ochroleuca* (Mexican poppy).

However, as depicted in Photograph 14.8, mature stands of Eucalypts remain within the narrow riparian zone. Instream complexity is associated with heterogeneous substrates, bank cuttings and instream debris, however pooling and riffle habitats are likely to form only after extended periods of rain.

The Mainland GTP RoW has been positioned parallel to an existing pipeline, which has been consolidated using rock and wire mesh. In order to minimise the amount of clearing necessary within the riparian zone, the Mainland GTP RoW will bisect the waterway on a perpendicular angle.

The Clematis Creek crossing, like most other watercourses within the catchment, is ephemeral, and flow is dependent upon heavy rainfall. As a result, at the proposed crossing site, Clematis Creek is devoid of aquatic vegetation, and is considered unlikely to support permanent populations of conservation significant species. Furthermore, no permanent breeding places for aquatic or semi-

aquatic fauna are likely to occur within the vicinity of the proposed crossing. Hollow-bearing trees within the riparian zone offer breeding habitat for arboreal fauna, thus management measures will be necessary in order to mitigate the potential impacts associated with vegetation clearing within this area.



Photograph 14.8 Looking upstream at the proposed Mainland GTP RoW crossing on Clematis Creek

May Creek

May Creek is an ephemeral system and tributary of Clematis Creek, within the Central Highlands sub-catchment of the Fitzroy Basin. May Creek is situated to the west of Arcadia Valley Road.

The local May Creek catchment has been heavily cleared as a result of agricultural land use (ie intense grazing), particularly within the mid and lower reaches. As a result, the watercourse is largely devoid of trailing vegetation within these regions. Furthermore, the riparian vegetation along the mid and lower reaches of May Creek is considered highly fragmented as a result of historical clearing, land use and edge effects. The upper reaches of this creek system are considered heavily wooded, in association with the Expedition Ranges.

The Mainland GTP RoW bisects the lower reach of May Creek, where DERM mapping (2010) indicates the reach as a stream order 3. The proposed Mainland GTP RoW has been positioned to run parallel to an existing pipeline, in an area that has been highly disturbed. Aerial photographic analysis suggests that the width of riparian vegetation at the proposed crossing point is less than 20 m.

The May Creek crossing, like most other watercourses within the catchment, is ephemeral, and flow is dependent upon heavy rainfall. As a result, May Creek is considered unlikely to support permanent populations of the Fitzroy River turtle, White-throated snapping turtle or Platypus.

Deep Creek

Deep Creek is located along the northwest portion of the Mainland GTP RoW, within the Central Highlands sub-catchment of the Fitzroy Basin.

The local Deep Creek catchment has been heavily cleared as a result of agricultural land use (ie grazing and cropping). As a result, the watercourse is largely devoid of trailing vegetation, and exhibits a narrow riparian zone (less than 30 m wide) for the majority of the length.

The Mainland GTP RoW bisects the mid reach of Deep Creek (stream order 3) and has been positioned within a segment of the waterway that has been previously disturbed as a result of pipeline installation.

The State of the Rivers report (DPI 2000) indicates that within the vicinity of the proposed crossing, Deep Creek exhibits very poor channel diversity (less than 20%), very poor riparian and aquatic vegetation condition and poor (20-40%) aquatic habitat.

Deep Creek is ephemeral with water flow being dependent upon high levels of rainfall and thus no permanent aquatic habitat exists for species such as the White-throated snapping turtle, Fitzroy River turtle or Platypus. Furthermore, no animal breeding places are expected to occur within the vicinity of the proposed Deep Creek crossing.

Unnamed waterway 5

This unnamed watercourse is located within the north-western region of the Mainland GTP RoW. The upper reaches of this waterway occurs within the adjacent Mount Nicholson State Forest. This unnamed watercourse is located to the north of Deep Creek.

The local waterway catchment has been heavily cleared within the lower reaches, as a result of agricultural land use (ie grazing). As a result, this segment of the watercourse is largely devoid of trailing and riparian vegetation. The mid and upper reaches of this waterway are considered heavily wooded and are associated with the State Forest.

The Mainland GTP RoW traverses this watercourse within the mid reach, where DERM mapping (2010) classifies the reach as a stream order 3.

Review of recent aerial photographs of the proposed crossing reveals that riparian vegetation within the vicinity has been subjected to previous clearing associated with the installation of a previous pipeline. However, riparian vegetation within the surrounding areas is considered largely intact. The Mainland GTP RoW has been positioned alongside the existing pipeline and will bisect the waterway on a perpendicular angle, thus minimising the amount of clearing necessary within the riparian zone.

As with most other watercourses within the region, this watercourse is considered ephemeral, in which flow requires heavy rainfall. Thus, no permanent aquatic habitat is expected at this location.

Unnamed palustrine wetland

The Mainland GTP RoW will result in the traversal of DERM (2010) a mapped palustrine wetland (Primarily vegetated non-channel environments of less than 8 hectares. They include billabongs, swamps, bogs, springs, soaks etc, and have more than 30% emergent vegetation (www.epa.qld.gov.au/wetlandinfo)), situated to the west of Prospect Creek. This wetland is mapped by DERM (2010) as Regional Ecosystem (RE) 11.3.1b, with an endangered classification under the Vegetation Management Act 1999 (VMA). This RE is described as:

*A Palustrine wetland (eg vegetated swamp), associated with an open-forest that is dominated by Brigalow (*Acacia harpophylla*) and/or Belah (*Casuarina cristata*), generally with scattered emergent *Eucalyptus* spp. (such as *E. coolabah*, *E. largiflorens*, *E. populnea*, *E. orgadophila*, and *E. pilligaensis*). A low tree layer may also be present, and include species such as *Terminalia* spp., *Eremophila* spp. and *Lysiphyllum* spp. The ground layer is typically sparse with *Muehlenbeckia florulenta* and a variety of sedges prominent in depressions.*

This RE community is typically associated with closed and drainage depressions on Cainozoic alluvial plains. Characteristic landforms include drainage floors, back-swamps and abandoned channels. Associated soils are predominantly deep to very deep cracking clays, sometimes with gilgai or texture contrast soils with sandy surface (particularly where *Eucalyptus populnea* is present).

No suitable habitat for the Fitzroy River turtle, White-throated snapping turtle or Platypus occurs, as a result of the lack of deep pools. Given the disturbed nature of this wetland (as a result of historical land clearing and agricultural land use) it is not expected that animal breeding places exist at this

location. Review of the Wildlife Online database (DERM 2010), indicates that no conservation significant aquatic species have been recorded within 10 km of this wetland.

Prospect Creek

Prospect Creek is an ephemeral system that flows into the adjoining Zamia Creek following periods of heavy rainfall.

The local Prospect Creek catchment has been heavily cleared as a result of agricultural land use (ie grazing and cropping). As a result, the watercourse is largely devoid of trailing vegetation, and exhibits a narrow riparian zone (less than 30 m wide) for the majority of the length.

The Mainland GTP RoW bisects the mid reach of Prospect Creek (stream order 4), where the trailing and riparian vegetation combined measure approximately 300 m. In order to minimise the clearing footprint associated with this vegetation, the proposed crossing has been positioned to the immediate south of an existing pipeline. Furthermore, the Mainland GTP RoW will bisect Prospect Creek perpendicularly to avoid unnecessary clearing within the riparian zone.

At the proposed Prospect Creek crossing, the State of the Rivers report (DPI 1995) indicates that this segment exhibits moderate channel diversity (40-60%), with poor (20-40%) aquatic habitat condition, and very poor (less than 20%) aquatic and riparian vegetation condition. Review of recent aerial photography confirms the disturbed state of the riparian vegetation at the proposed crossing point. Despite this, the State of the Rivers report (DPI 1995) concludes that the overall condition of this segment of Prospect Creek is considered moderate (40-60%).

Water flow at the proposed Prospect Creek crossing point is dependent upon high levels of rainfall and thus no permanent aquatic habitat exists for species such as the White-throated snapping turtle, Fitzroy River turtle or Platypus.

Unnamed waterway 6

This unnamed waterway is a tributary of Zamia Creek (which runs parallel to the Mainland GTP RoW), located to the east of Prospect Creek.

The local waterway catchment has been heavily cleared as a result of agricultural land use (ie grazing and cropping). As a result the watercourse is largely devoid of trailing and riparian vegetation.

The Mainland GTP RoW bisects the lower reach of the unnamed watercourse, where DERM mapping (2010) classifies the segment as a stream order 3.

Review of recent aerial photographs of the proposed crossing reveals that riparian vegetation within the vicinity has been subjected to previous clearing associated with the installation of an existing pipeline. The width of the fragmented riparian and trailing vegetation associated with this waterway crossing is estimated to be approximately 120 m. In order to minimise the clearing footprint at the proposed crossing point, the Mainland GTP RoW has been positioned alongside an existing pipeline and will bisect the waterway on a perpendicular angle.

No permanent aquatic habitat is expected at this location, and therefore it is unlikely that conservation significant species such as the White-throated snapping turtle, Fitzroy River turtle, and Platypus would occur.

Conciliation Creek

Conciliation Creek is an ephemeral system, located to the west of Mimosa Creek, within the Dawson sub-catchment of the Fitzroy Basin.

The local Conciliation Creek catchment has been heavily cleared as a result of agricultural land use (ie grazing), particularly within the mid and lower reaches. As a result, the watercourse is largely devoid of trailing vegetation within these regions. Furthermore, the riparian vegetation along the mid and lower reaches of Conciliation Creek is considered highly fragmented as a result of historical clearing, land use and edge effects.

The Mainland GTP RoW bisects the lower reach of Conciliation Creek (stream order 5), at the Zamia Creek junction. The Mainland GTP RoW has been positioned to run parallel to an existing pipeline, and thus occurs within an area of previously disturbed riparian vegetation.

The State of the Rivers report (DPI 1995) indicates that at the Conciliation Creek crossing, this watercourse exhibits moderate channel diversity (40-60%), very poor riparian vegetation condition (less than 20%), and very poor aquatic vegetation and habitat condition.

The Mainland GTP RoW bisects approximately 360 m of riparian vegetation associated with Conciliation Creek. The riparian zone is a primarily large *Angophora* spp. and *Eucalyptus tereticornis*, with an understorey dominated by weed and introduced species. Within this area the active channel is approximately 50 m wide and is primarily sand (Photograph 14.9).

The Conciliation Creek crossing, like most other watercourses within the catchment, is ephemeral, and flow is dependent upon heavy rainfall. As a result, Conciliation Creek (at the point of crossing) is considered unlikely to support populations of the Fitzroy River turtle or the White-throated snapping turtle. Furthermore, no permanent habitat occurs for Platypus within this segment of Conciliation Creek during low/no flow periods.



Photograph 14.9 Conciliation Creek looking towards Zamia Creek junction

Brolga Gully

Brolga Gully is an ephemeral tributary of the adjoining Zamia Creek, to the west of the Dawson River.

The local Brolga Gully catchment has been heavily cleared as a result of mixed agricultural land use (ie grazing and cropping). As a result, the watercourse is largely devoid of trailing vegetation, particularly within the mid and upper reaches. Trailing vegetation occurs predominately within the lower reach, towards Mimosa Creek. The riparian vegetation along Brolga Gully, particularly within the mid reach where the Mainland GTP RoW bisects, is considered fragmented as a result of historical clearing, land use and edge effects.

The Brolga Gully crossing (stream order 3) occurs within the mid reach, where it is considered highly disturbed, and devoid of riparian and aquatic vegetation. The Mainland GTP RoW is positioned immediately adjacent to an existing pipeline.

The Brolga Gully crossing, like most other watercourses within the catchment, is ephemeral, and flow is dependent upon heavy rainfall. As a result, Brolga Gully no permanent suitable habitat occurs for aquatic and semi aquatic fauna including the Fitzroy River turtle, White-throated snapping turtle and Platypus.

Mimosa Creek

Mimosa Creek is a major ephemeral tributary of the Dawson River, located to the west of the Dawson Range and Bears Lagoon Road.

The local Mimosa Creek catchment has been heavily cleared as a result of mixed agricultural land use (ie grazing and cropping). As a result, the watercourse exhibits regions of fragmented trailing and riparian vegetation.

The Mainland GTP RoW bisects the mid reach of Mimosa Creek, where DERM mapping (2010) indicates it is a stream order 6.

The State of the Rivers report (DPI 1995) indicates that at the proposed crossing site the Mimosa Creek exhibits very poor channel diversity and aquatic vegetation condition (less than 20%), and very poor aquatic habitat. However, the report indicates that this stretch of the creek exhibits very good riparian vegetation condition (greater than 80%). Conversely, review of recent aerial photographs has concluded that the Mimosa Creek crossing point has experienced disturbance to the surrounding riparian vegetation through historical land clearing and current agricultural practices. The estimated width of riparian vegetation at the proposed crossing point is approximately 40 m.

As a result of the ephemeral nature of the Mimosa Creek at the proposed crossing site, it is considered unlikely that this creek provides suitable habitat for the White-throated snapping turtle and the Dawson River turtle. Possible habitat may occur during periods of high flow for other aquatic fauna including Platypus, however it is unlikely to be an established breeding place.

Denby Creek

Denby Creek forms a pseudo-anabranch, diverting from the Dawson River in the north, and reconnecting with Mimosa creek (a tributary of the Dawson River) in the south. Denby Creek is nestled between, and runs parallel to the Dawson River and Dawson Range.

The local Denby Creek catchment has been heavily cleared as a result of agricultural land use (ie grazing). As a result, the watercourse is largely devoid of trailing vegetation, with the exception of the upper reaches that occur within the Dawson Range. The riparian vegetation along Denby Creek is restricted to a narrow (0 -150 m wide) strip along the entirety of the watercourse.

The Mainland GTP RoW bisects the mid reach of Denby Creek, where DERM mapping (2010) indicates it is a stream order 3. The riparian zone at this crossing point is considered highly disturbed, and vegetation occurs as an 80 m wide strip. In order to minimise the clearing extent within the riparian zone, the Mainland GTP RoW will bisect Denby Creek perpendicularly.

As with most other Dawson River tributaries, Denby Creek is ephemeral with water flow being dependent upon high levels of rainfall. Water flow is dependent upon high levels of rainfall, and thus no permanent aquatic habitat exists for species such as the White-throated snapping turtle, Fitzroy River turtle or Platypus.

Dawson River (northern)

The Dawson River extends approximately 781 km, commencing at the junction of the Mackenzie and Fitzroy Rivers in the north of the Dawson River Catchment, continuing in a southern and subsequent western direction.

The local Dawson River catchment has been heavily cleared as a result of mixed agricultural land use (ie grazing and cropping). As a result, the River is largely devoid of trailing vegetation, particularly within the mid and lower reaches (where it joins the Mackenzie and Fitzroy Rivers). The riparian vegetation along the Dawson River, particularly within the mid and lower reaches is considered typically fragmented as a result of historical clearing, land use and edge effects.

The Mainland GTP RoW bisects mid reach of the Dawson River (Photograph 14.10), where DERM mapping (2010) indicates it is a stream order 8.

The State of the Rivers report (DPI 1995) indicates that the Dawson River (northern) crossing exhibits very poor channel diversity (less than 20%), very good riparian vegetation condition (greater than 80%), and very poor aquatic habitat condition.

A pool approximately 500 m in length and 10 m wide, extends from the former crossing site to upstream of the RCR019 alignment. The pool is relatively shallow, with a good instream habitat, including a heterogeneous substrate, fallen logs and undercut banks. Macrophyte beds, including such species as *Otellia alismoides* and *Potamogeton crispus* were also intermittently distributed along the length of the pool. Algae were also prevalent in some areas which indicates a degree of stagnation within the pool.

The banks of the pool are relatively intact with a good mix of native vegetation (eg *Melaleuca* spp.) along the riparian zone. The riparian zone also provides a significant amount of overhanging vegetation.

Above the high water bank on either side of the River there is also a good cover of native vegetation (100 to 150 m wide).

There are however some localised impacts, including the aggradation of sediment, proliferation of weeds such as Parthenium and also erosion from *Sus scrofa* (Feral pig) activity. Parthenium is a declared Class 2 plant under the *Land Protection (Pest and Stock Route Management) Act 2002* (LP Act) and also a Weed of National Significance. Under the LP Act landowners must take reasonable steps to keep land free of Class 2 pests.

This Dawson River crossing is considered to possibly support the Fitzroy River turtle and the White-throated snapping turtle. Previous studies conducted (Hamann et al 2007) have identified the White-throated snapping turtle as occurring within the Dawson River, to the north of this Dawson River crossing. The Fitzroy River turtle is known within the Dawson River system (DERM 2010a), and has been recorded from the permanent pool associated with Baralaba Weir. Thus it is considered a possible resident within the vicinity of this crossing and the species may use the area for nesting during flows (ie the riparian zone is also suitable nesting habitat for this species (ie RE11.3.25)). The Dawson River is also likely to support a stable population of Platypus as a result of the river geomorphology and permanent water resources.



Photograph 14.10 Dawson River, looking downstream from the Mainland GTP RoW

Back Creek

Back Creek is a tributary of the adjacent Dawson River, to the west of Kianga Creek. As with the majority of the Dawson River system, Back Creek is considered ephemeral, as indicated by the sandy

stream beds and an absence of aquatic vegetation (refer to Photograph 14.11). The frequency of flow is expected to be restricted to periods of heavy rainfall.

The local catchment has been heavily cleared as a result of agricultural land use, thus trailing vegetation is considered highly fragmented. The riparian vegetation along Back Creek is considered typically fragmented as a result of historical clearing, land use and edge effects.

The Mainland GTP RoW bisects the mid reach of Back Creek, where it is indicated by DERM mapping (2010) as a stream order 3.

The Back Creek crossing is not considered to possess permanent, suitable habitat for aquatic fauna. However, during periods of high flow, Back Creek may offer transient foraging and movement opportunities for such species. No animal breeding places are expected to occur within close proximity to the proposed crossing.



Photograph 14.11 Back Creek in flow August 2010

Kianga Creek

Kianga Creek occurs between the Dawson River to the west and Banana Creek to the east. Kianga Creek forms an anabranch of the Dawson River, diverting from the main channel in the north, and reconnecting to the Dawson River in the south.

The local Kianga Creek catchment has been heavily cleared as a result of agricultural land use (ie cropping and grazing) and mining activities associated with Moura mine. Thus, trailing vegetation is considered largely devoid along the majority of Kianga Creek, and the riparian vegetation is considered fragmented.

The Mainland GTP RoW bisects the lower reach of Kianga Creek, at the junction of the formed Kianga Creek anabranch. At the point of the proposed crossing (stream order 4), the State of the Rivers report (DPI 1995) indicates that the creek exhibits very poor channel diversity (less than 20%), riparian and aquatic vegetation condition, and aquatic habitat condition.

Aerial photographic analysis suggests that the riparian vegetation within the crossing vicinity is highly disturbed through historical land clearing and agricultural use (ie grazing). Review of recent aerial photographs reveal the riparian zone at the proposed Kianga Creek crossing measures approximately 100 m in width.

As a result of the highly disturbed nature of Kianga Creek, it is considered unlikely that suitable habitat for the White-throated snapping turtle, Fitzroy River turtle or Platypus occurs within the vicinity of the crossing point.

Banana Creek

Banana Creek is an ephemeral tributary of the Dawson River, to the east of Kianga Creek.

The local Banana Creek catchment has been heavily cleared as a result of high intensity agricultural land use (ie cropping). As a result, the watercourse crossing is largely devoid of trailing vegetation. The riparian vegetation along Banana Creek, in particular the proposed crossing, is considered fragmented as a result of historical clearing, land use and edge effects.

The Mainland GTP RoW bisects the mid reach of Banana creek, where DERM mapping (2010) illustrates the reach as a stream order 5. In order to minimise the level of disturbance to the creek, the Mainland GTP RoW has been positioned to traverse alongside an existing pipeline, which has been reinforced by rock.

The frequency of flow through Banana Creek, and in particular the crossing site, is expected to be restricted to periods of heavy rainfall (as depicted in Photograph 14.12). During the dry season, no pools are expected to occur within the vicinity of the pipeline crossing.

Banana Creek, although a tributary of the Dawson River, is unlikely to support resident populations of the Fitzroy River turtle or the White-throated snapping turtle as a result of the disturbed nature of the watercourse, and deficiency of macrophytes. No suitable habitat (ie flowing, riffles, aquatic vegetation) exists at the proposed crossing point for such species. Furthermore, as a result of the topography and shallow muddy waters, it is considered unlikely that Platypus reside within the vicinity of the proposed crossing.



Photograph 14.12 Banana Creek in flow in August 2010

Police Camp Creek

Police Camp Creek is an ephemeral tributary of the Dawson River, which adjoins Banana Creek to the south of Baralaba Banana Road, and terminates upstream of the Leichhardt Highway.

The local Police Camp Creek catchment has been heavily cleared as a result of high intensity agricultural land use (ie cropping and grazing). As a result, the watercourse crossing is largely devoid of trailing vegetation. The riparian vegetation along Police Camp Creek is considered fragmented as a result of historical clearing, land use and edge effects.

The Mainland GTP RoW bisects Police Camp Creek on two occasions. The upstream crossing occurs within the mid reach of Police Camp Creek and is mapped by DERM (2010) as a stream order 3, whilst the downstream crossing occurs within the upper reach and is mapped as a stream order 4.

Aerial photograph analysis suggests that the riparian vegetation within the vicinity of both crossing sites is highly disturbed. The width of riparian vegetation at the upstream crossing is estimated to be less than 30 m with no trailing vegetation, whilst the downstream crossing site exhibits trailing and riparian vegetation with a combined width of approximately 100 m.

Water flow at the proposed crossing points is dependent upon high levels of rainfall, and thus no permanent aquatic habitat exists for species such as the White-throated snapping turtle, Fitzroy River turtle or Platypus.

Unnamed waterway 7

This unnamed waterway is a tributary of the Dawson River, which connects directly to Police Camp Creek and subsequently Banana Creek.

The local waterway catchment has been heavily cleared as a result of agricultural land use (ie grazing). As a result this watercourse is largely devoid of trailing and riparian vegetation.

The Mainland GTP RoW bisects the mid reach of the unnamed watercourse, where DERM mapping (2010) classifies the segment as a stream order 3.

Review of recent aerial photographs of the proposed crossing reveals that it is devoid of trailing vegetation, and riparian vegetation is fragmented. The width of the riparian vegetation associated with this waterway crossing is estimated to be approximately 25 m. In order to minimise the clearing footprint at the proposed crossing point, the Mainland GTP RoW has been positioned alongside an existing pipeline and will bisect the waterway on a perpendicular angle.

Review of recent aerial photographs of the proposed crossing reveals that riparian vegetation within the vicinity has been subjected to previous clearing associated with agricultural activities. Furthermore, aerial photographs reveal that damming of the unnamed watercourse has occurred upstream.

No permanent aquatic habitat is expected at this location, and therefore it is unlikely that conservation significant species such as the White-throated snapping turtle, Fitzroy River turtle, and Platypus would occur.

Sellheim Creek

Sellheim Creek is an ephemeral system that forms a tributary of the adjacent Neville Creek.

The local Sellheim Creek catchment has been heavily cleared as a result of agricultural land use (ie grazing). As a result, the watercourse crossing is largely devoid of trailing vegetation. The riparian vegetation along Sellheim Creek is considered highly fragmented as a result of historical clearing, land use and edge effects.

The Mainland GTP RoW bisects the mid reach of Sellheim Creek, where DERM mapping (2010) classifies this segment of the waterway as a stream order 3.

At the proposed Sellheim Creek crossing the State of the Rivers report (DPI 1995) indicates that this segment exhibits moderate channel diversity (40-60%), with very poor (less than 20%) aquatic and riparian vegetation condition and aquatic habitat condition. Review of recent aerial photography (Google Earth 2010) confirms the disturbed state of the riparian vegetation at the proposed crossing point. Despite this, the State of the Rivers report (DPI 1995) concludes that the overall condition of this segment of Sellheim Creek is considered moderate (40-60%).

Water flow at the proposed Sellheim Creek crossing point is dependent upon high levels of rainfall, and thus no permanent aquatic habitat exists for species such as the White-throated snapping turtle, Fitzroy River turtle or Platypus.

Neville Creek

Neville Creek is a major ephemeral tributary of the Callide Creek, commencing to the north of the junction of Biloela Duinga Road and the Burnett Highway, and terminating to the south of Dawson Highway and to the east of Banana Holding Road.

The local Neville Creek catchment has been heavily cleared as a result of high intensity agricultural land use (ie cropping and grazing). As a result, the watercourse crossing is largely devoid of trailing vegetation. The riparian vegetation along Neville Creek is considered fragmented as a result of historical clearing, land use and edge effects.

The Mainland GTP RoW bisects the upper reach of Neville Creek (stream order 3), approximately 40 m to the south of an existing pipeline. The riparian vegetation at the proposed crossing site is considered highly disturbed and measures approximately 30 m in width (Photograph 14.13). In order to minimise the extent of clearing within the Neville Creek riparian zone, the Mainland GTP RoW will bisect the watercourse on a perpendicular angle.

The State of the Rivers report (DPI 1995) indicates that this stretch of Neville Creek typically exhibits moderate (40-60%) channel diversity, with very poor (less than 20%) aquatic and riparian vegetation condition. The aquatic habitat value was also reported to be in very poor condition.

As with most other tributaries within the catchment, Neville Creek is considered ephemeral. Water flow at the proposed crossing point is dependent upon high levels of rainfall, and thus no permanent aquatic habitat exists for species such as the White-throated snapping turtle, Fitzroy River turtle or Platypus.



Photograph 14.13 Neville Creek in flow August 2010

Unnamed waterway 8

This unnamed waterway is a tributary of the Neville and Callide Creek systems, and is located to the south of Argoon Road.

The local waterway catchment has been heavily cleared as a result of agricultural land use (ie cropping and grazing). As a result this watercourse is largely devoid of trailing and the riparian vegetation is typically limited to a width of 50 m for much of its length.

The Mainland GTP RoW bisects the upper reach of the unnamed watercourse, where DERM mapping (2010) classifies the segment as a stream order 4.

Review of recent aerial photographs of the proposed crossing reveals that riparian vegetation is fragmented and clearing has occurred to the immediate north for the construction of an existing pipeline. Trailing and riparian vegetation at the proposed crossing point, is estimated to measure approximately 180 m in width. In order to minimise the clearing footprint, the Mainland GTP RoW will bisect this watercourse in a perpendicular manner, adjacent to a previously cleared pipeline corridor.

Aerial photographs reveal that damming of the unnamed watercourse has occurred upstream, and a permanent, natural, waterbody, is situated approximately 350 m to the north of the crossing (Lilly Lagoon).

At the proposed crossing point, water flow is expected to be limited to times of heavy rainfall. Thus, no permanent aquatic habitat is expected at this location, and therefore it is unlikely that conservation significant species such as the White-throated snapping turtle, Fitzroy River turtle, and Platypus would occur.

Unnamed waterway 9

This unnamed waterway is a formed tributary of Unnamed waterway 8, that ultimately connects to Kroombit Creek.

The local waterway catchment has been heavily cleared as a result of agricultural land use (ie cropping and grazing). As a result, this watercourse is largely devoid of trailing and the riparian vegetation is typically limited to a width of 40 - 70 m for much of its length.

The Mainland GTP RoW bisects the upper reach of the unnamed watercourse, where DERM mapping (2010) classifies this segment as a stream order 6.

Review of recent aerial photographs of the proposed crossing reveals that no trailing vegetation exists, and riparian vegetation is fragmented. Previous clearing has occurred to the immediate north of the proposed crossing for the construction of an existing pipeline. Trailing and riparian vegetation, at the proposed crossing point, is estimated to measure approximately 70 m in width. In order to minimise the clearing footprint, the Mainland GTP RoW will bisect this watercourse in a perpendicular manner, adjacent to a previously cleared pipeline corridor.

Aerial photographs also reveal that damming of the unnamed watercourse has occurred upstream.

At the proposed crossing point, water flow is expected to be limited to times of heavy rainfall. Thus, no permanent aquatic habitat is expected at this location, and therefore it is unlikely that conservation significant species such as the White-throated snapping turtle, Fitzroy River turtle, and Platypus would occur.

Kroombit Creek

Kroombit Creek is a formed ephemeral tributary of the Callide Creek that originates to the south of McCanns Road, and terminates in the Kroombit Tops National Park, approximately 70 km to the south-west. To the south of Argoon Road, Kroombit Creek splits into a western channel, that adjoins Unnamed waterway 9.

The local Kroombit Creek catchment has been heavily cleared as a result of agricultural land use (ie grazing and cropping), particularly within the mid and lower reaches. As a result, the watercourse is largely devoid of trailing vegetation, and riparian zones are considered disturbed within these regions. The upper reaches of this creek system are considered heavily wooded, in association with the Kroombit Tops National Park.

The Mainland GTP RoW bisects both the Kroombit Creek main channel and the western channel, within the creek's lower reach. The riparian vegetation within both channels of Kroombit Creek measures approximately 70 m in width. In order to reduce the clearing footprint, the Mainland GTP RoW will bisect Kroombit Creek perpendicularly, and has been positioned to run parallel to an existing pipeline, where the riparian zone has previously been disturbed.

At the proposed Kroombit Creek crossing (stream order 6), the State of the Rivers report (DPI 1995) indicates that the channel diversity is poor (20-40%), riparian and aquatic vegetation is very poor (less than 20%), and the aquatic habitat is considered poor.

Previous studies conducted (Hamann et al 2007) have identified White-throated snapping turtles as occurring within the adjacent Callide Creek. However, as a result of the highly disturbed nature of the Kroombit Creek crossing and the lack of permanent water, it is considered unlikely that suitable habitat for the White-throated snapping turtle, Fitzroy River turtle or Platypus occurs within the vicinity of the crossing point.

Callide Creek

Callide Creek (Photograph 14.14) is located within the north-eastern region of the Mainland GTP RoW, to the north of Biloela.

Review of aerial photographs indicates that the local Callide Creek catchment has been heavily cleared within the lower and mid reaches, as a result of mixed agricultural land use (ie grazing and cropping). As a result, these segments of the watercourse are largely devoid of trailing and riparian vegetation. The upper reaches of this waterway are considered heavily wooded, upstream of Lake Callide.

The Mainland GTP RoW bisects mid reach of Callide Creek, where DERM mapping (2010) indicates the reach as a stream order 5. The Mainland GTP RoW has been positioned to run parallel to an existing pipeline, and thus occurs within an area of previously disturbed riparian vegetation.

The State of the Rivers report (DPI 1995) indicates that, at the Callide Creek crossing, this watercourse exhibits very poor channel diversity (less than 20%), poor riparian vegetation condition (20-40%), and very poor aquatic vegetation condition. Despite this, the State of the Rivers report indicates that the aquatic habitat condition is considered to be good (60-80%).

Previous studies conducted (Hamann et al 2007) have identified White-throated snapping turtle within the upstream reaches of the Callide Creek, within close proximity to Lake Callide. However, due to the ephemeral nature of this creek at the proposed crossing site, it is considered unlikely to support populations of the Fitzroy River turtle or the White-throated snapping turtle. Furthermore, no permanent habitat occurs for Platypus within this segment of Callide Creek during low/no flow periods.

Callide Creek (Old Channel)

Callide Creek (Old Channel) is located to the east of Callide Creek and to the north of the Biloela township.

Review of aerial photographs indicates that the local Callide Creek (Old Channel) catchment has been heavily cleared along its entirety, as a result of high intensity agricultural land use (ie cropping). As a result, this watercourse is largely devoid of trailing, and exhibits a narrow riparian zone.

The Mainland GTP RoW bisects the lower reach of Callide Creek (Old Channel), approximately 450 m from the junction of Callide Creek. DERM mapping (2010) indicates the crossing point as a stream order 5. The Mainland GTP RoW has been positioned within close proximity to an existing pipeline, and thus occurs within an area of previously disturbed riparian vegetation.

Akin to Callide Creek, Callide Creek (Old Channel) is an ephemeral system in which flow is dependent upon heavy rainfall. As depicted in Photograph 14.14, at the proposed crossing point, the channel banks are pastoral grasslands, lacking aquatic vegetation and exhibit poor instream complexity.

As a result of the ephemeral nature of this creek, it is considered unlikely to support populations of the Fitzroy River turtle or the White-throated snapping turtle at the proposed crossing. Furthermore, no permanent habitat occurs for Platypus within this segment of Callide Creek (Old Channel) during low/no flow periods.



Photograph 14.14 Callide Creek (Old Channel) in August 2010

Unnamed waterway 10

This unnamed waterway is located to the east of Callide Creek and Callide Creek (Old Channel).

The local waterway catchment has been heavily cleared as a result of agricultural land use (ie cropping grazing). As a result, this watercourse is largely devoid of trailing vegetation, and riparian vegetation considered fragmented.

The Mainland GTP RoW will result in the bisection of the mid reaches of this unnamed waterway on five occasions. DERM mapping (2010) classifies this unnamed watercourse as a stream order 3 at all of the proposed crossing points.

Review of recent aerial photographs of the proposed crossing points reveals that riparian vegetation within the vicinity has been subjected to previous clearing associated with agricultural activities, and the previous construction activities associated with an existing pipeline. It must be noted that substantial cloud cover impedes the aerial photographic analysis of these crossing sites. However, conclusions have been drawn based on the level of clearing along segments of the watercourse within close proximity to the proposed crossings.

At the proposed crossing point, water flow is expected to be limited to times of heavy rainfall. Thus, no permanent aquatic habitat is expected at this location, and therefore it is unlikely that conservation significant species such as the White-throated snapping turtle, Fitzroy River turtle, and Platypus would occur.

Collards Creek

Collards Creek is a large ephemeral tributary of the Bell Creek system that traverses the Dawson Highway parallel and to the south of Bell Creek.

The local Collards Creek catchment has been heavily cleared in areas where agricultural activities are suitable, particularly within the upper and lower reaches. As a result, the watercourse exhibits large patches devoid of trailing vegetation. However, where agricultural land use is unsuitable (and thus clearing has not occurred), trailing vegetation is largely intact.

The Mainland GTP RoW intersects the lower reach of Collards Creek. DERM mapping (2010) classifies Collards Creek as a stream order 3 at all of the proposed crossing points.

The State of the Rivers report (DPI 1995) indicates that at the proposed crossing of Collards Creek, the reach exhibits a poor aquatic habitat condition (20-40%), poor riparian vegetation condition, and very poor channel diversity (less than 20%).

Review of recent aerial photographs of the proposed crossing reveals minimal trailing vegetation exists to the west, whilst dense riparian and trailing vegetation occurs to the north and south of the proposed crossing. In order to minimise the clearing footprint, the Mainland GTP RoW will bisect this watercourse in a perpendicular manner.

It is unlikely that suitable habitat occurs for the Fitzroy River turtle, and the White-throated snapping turtle, as Collards Creek is considered to be outside of their known distribution. Furthermore, due to the ephemeral nature of Collards Creek at the proposed crossing point, it is unlikely that suitable habitat occurs for aquatic species such as the Platypus. No animal aquatic breeding places are expected to occur within the vicinity of the proposed crossing site.

Bell Creek

Bell Creek (Photograph 14.15) is an ephemeral tributary of the Callide Creek system, to the south-west of the Calliope River. The Mainland GTP RoW is positioned approximately 700 m from the Dawson Highway.

The local Bell Creek catchment has been heavily cleared as a result of agricultural land use (ie grazing). As a result, the watercourse is largely devoid of trailing vegetation, particularly within the mid reach, where the Mainland GTP RoW bisects. Likewise, the riparian vegetation along Bell Creek, particularly within the mid reach, is considered fragmented as a result of historical clearing, land use and edge effects.

The State of the Rivers report (DPI 1995) indicates that Bell Creek exhibits a poor aquatic habitat condition (20-40%), with very poor channel diversity (less than 20%).

The Mainland GTP RoW crossing has been positioned within a segment of the watercourse that has previously been cleared (ie riparian zone approximately 10 m wide), thus minimising the extent of vegetation clearing necessary for the construction and operation of the pipeline. DERM mapping (2010) classifies the alignment crossing point as stream order 3.

It is unlikely that suitable habitat occurs for the Fitzroy River turtle, and the White-throated snapping, as Bell Creek is considered to be outside of their known distribution. Furthermore, due to the ephemeral nature of Bell Creek at the proposed crossing point, it is unlikely that suitable habitat occurs for aquatic species such as the Platypus. No animal breeding places are expected to occur within the vicinity of the proposed crossing site.



Photograph 14.15 Section of Bell Creek intersected by the alternative Mainland GTP RoW option

Calliope River

With a channel length of approximately 100 km, the Calliope River is an unregulated system with a perennial baseflow. Flowing in an easterly direction from the Calliope Ranges (headwaters), the Calliope River discharges into Port Curtis, north of Gladstone.

The upper reaches of the Calliope River system have been described as having a high to very high ecological value (C&R Consulting 2005). An outstanding feature of Calliope River system is the extent and diversity of aquatic macrophyte assemblages, particularly in the periods following peak flow events. As noted in the *Calliope River Basin Draft Water Resource Plan: Ecological Assessment Report* (C&R Consulting 2005), other ecological values of the Calliope River system include:

- Deepwater/freshwater refugia
- Riffle habitats
- High integrity fish communities
- Habitat diversity in the flood channel
- Relatively intact riparian zone
- Frontage woodland on alluvial terraces, levees and floodplains
- Floodplain wetlands
- Remnant vegetation (ie mapped as Regional Ecosystems)

The local Calliope River catchment has been heavily cleared as a result of mixed agricultural land use (ie grazing and cropping), particularly within the mid reach. As a result, the watercourse is largely devoid of trailing vegetation. The trailing and riparian vegetation within the upper and lower reaches of the river are considered less disturbed and heavily wooded in places.

The Mainland GTP RoW bisects the mid reach of the Calliope River, where DERM mapping (2010) classifies it as a stream order 5. The riparian vegetation associated with the Calliope River crossing point spans approximately 130 m, and is considered structurally complex. Trailing vegetation surrounding the crossing is highly fragmented.

Within this area there are two main channels (refer Photograph 14.16 and Photograph 14.17). The stream complexity of the Calliope River within the vicinity of the proposed crossing site is considered high, exhibiting pools, baseline flows and riffles.

It is unlikely that suitable habitat occurs for the Fitzroy River turtle, and the White-throated snapping turtle, as the Calliope River is typically outside of their known distribution. Furthermore, due to the

ephemeral nature of the Calliope River at the proposed crossing point, it is unlikely that suitable habitat occurs for aquatic species such as the Platypus. No animal breeding places are expected to occur within the vicinity of the proposed crossing site.



Photograph 14.16 Calliope River



Photograph 14.17 Looking downstream towards the Mainland GTP RoW crossing on the eastern channel of the Calliope River

Unnamed waterway 11

This unnamed watercourse exists as an ephemeral tributary of the Calliope River, to the south of Harper Creek. As with most other watercourses within the region, this watercourse is considered ephemeral, in which flow requires heavy rainfall.

Review of aerial photographs indicates that the local watercourse catchment has been heavily cleared along its entirety, as a result of agricultural land use (ie grazing). As a result, this watercourse is largely devoid of trailing, and exhibits a narrow riparian zone typically measuring 0-10 m in width.

The Mainland GTP RoW bisects the mid reach of this unnamed waterway. DERM mapping (2010) indicates the crossing point as a stream order 3. The proposed crossing occurs to the east of Mount Alma Road, in an area that is highly disturbed (ie devoid of all trailing and riparian vegetation).

Unnamed waterway 12

This unnamed watercourse exists as an ephemeral tributary of the Calliope River, forming a branch of Harper Creek. As with most other watercourses within the region, this watercourse is considered ephemeral, in which flow requires heavy rainfall.

Review of aerial photographs indicates that the local watercourse catchment has been heavily cleared as a result of agricultural land use (ie grazing). Thus, this watercourse is largely devoid of trailing, and exhibits a narrow riparian zone typically measuring 0-50 m in width.

The Mainland GTP RoW bisects the lower reach of this unnamed waterway, approximately 800 m from the Harper Creek junction. DERM mapping (2010) indicates the crossing point as a stream order 3. The proposed crossing occurs to the south of Mount Alma Road, in an area that is highly disturbed (ie devoid of all trailing and minimal riparian vegetation).

It is unlikely that suitable habitat occurs for the Fitzroy River turtle, and the White-throated snapping turtle, as the tributaries of the Calliope River system are typically outside of their known distribution. Furthermore, due to the ephemeral nature of this waterway at the proposed crossing point, it is unlikely that suitable habitat occurs for aquatic species such as the Platypus. No animal breeding places are expected to occur within the vicinity of the proposed crossing site.

Harper Creek

Harper Creek is a tributary of Calliope River, in the eastern region of the Mainland GTP RoW (Photograph 14.18).

The local Harper Creek catchment has been heavily cleared as a result of mixed agricultural land use (ie grazing and cropping), particularly within the lower and mid reaches. As a result, the lower and mid reaches are largely devoid of trailing vegetation, and riparian vegetation is limited to a width of approximately 100 m. The trailing and riparian vegetation within the upper reaches of Harper Creek are considered heavily wooded.

The Mainland GTP RoW bisects the lower reach of Harper Creek, where DERM mapping (2010) indicates that at the proposed crossing, the watercourse is considered a stream order 4. Review of recent (2010) aerial photography indicates the approximate width of the riparian vegetation associated with the proposed crossing is 90 m. Photograph 14.18 illustrates the Harper Creek and associated riparian vegetation.

Despite the disturbed nature of the riparian zone and trailing vegetation at the proposed crossing, this region of the watercourse has good instream habitat, including one of the few areas along the Mainland GTP RoW with macrophyte beds (*Potamogeton crispus* (Curly Pondweed) and *Ottelia ovalifolia* (Swamp Lily)). Other instream habitat included, overhanging vegetation, large woody debris and detritus material. The Harper Creek crossing is considered to have moderate to high aquatic value, and is likely to be an important local refugia habitat for aquatic and terrestrial fauna during dry periods.

The Fitzroy River turtle and White-throated snapping turtle are not known to occur within tributaries of the Calliope River. However, it is possible that habitat for Platypus is present within Harper Creek, particularly downstream of the proposed crossing, towards the Calliope River.



Photograph 14.18 Permanent pool on Harper Creek, August 2010

Alarm Creek

Alarm Creek is a tributary of the Calliope River, located within the north-eastern region of the Mainland GTP RoW. The local Alarm Creek catchment has been heavily cleared for agricultural land use practices. As a result, the creek is largely devoid of trailing vegetation. Furthermore, the riparian vegetation associated with Alarm Creek is considered highly fragmented.

The Mainland GTP RoW bisects the lower reach of Alarm Creek, which is mapped by DERM (2010) as a stream order 3. The riparian vegetation at the proposed crossing has been cleared to the active channel and is in poor health (Photograph 14.19).

It is considered unlikely that this watercourse supports the Fitzroy River turtle or the White-throated snapping turtle, as these species do not typically occur within the Calliope River system. Possible habitat occurs for the Platypus, particularly downstream towards the Calliope River.



Photograph 14.19 Looking west toward the Mainland GTP RoW crossing on Alarm Creek

Gravel Creek

Gravel Creek is a tributary of Larcom Creek, in the eastern region of the Mainland GTP RoW. Gravel Creek bisects Mt Alma Road upstream of the proposed watercourse crossing.

The local Gravel Creek catchment has been heavily cleared for agricultural land use practices (ie grazing), particularly within the lower and mid reaches. As a result, the creek is largely devoid of trailing vegetation within these regions, and riparian vegetation is limited to an approximate 30 m width along the majority of its length. The upper reaches of Gravel Creek exhibit heavily wooded riparian zones and trailing vegetation.

The Mainland GTP RoW bisects the lower reach of Gravel Creek, upstream of the Larcom Creek junction. At the point where the Mainland GTP RoW bisects Gravel Creek (stream order 3), a small ephemeral anabranch has formed.

The riparian zone at the proposed crossing point is considered highly disturbed, with the width of the riparian vegetation being less than 20 m.

Water flow within Gravel Creek is ephemeral, and thus dependent upon high levels of rainfall. As a result, no permanent aquatic habitat exists for conservation significant species. The White-throated snapping turtle and the Fitzroy River turtle are not known to occur within tributaries of the Calliope River.

Larcom Creek

Larcom Creek is a major tributary of the Calliope River, which is sourced to the west of Mount Larcom and flows south-west prior to discharging into the Calliope River upstream of Castlehope. It is an ephemeral system which is distinguished by ephemeral watercourses in the upper reaches and a series of large, deep waterholes in the mid and lower reaches.

Larcom Creek is characterised by alluvial substrate and a narrow riparian zone similar to that present along the Calliope River and the lower reach of the creek. Adjacent land uses include grazing and linear infrastructure (eg gas pipeline and power easements) which have removed large areas of remnant vegetation.

The Mainland GTP RoW will bisect Larcom Creek on two occasions within the mid reach of the watercourse.

The downstream crossing (stream order 4) exhibits an approximate 130 m width of riparian vegetation (dominated by *M. viminalis*, with *Allocasuarina* spp.) which has been previously subjected to land clearing associated with Mount Alma Road, which runs parallel to the Mainland GTP RoW. Larcom Creek is ephemeral in this area and it is known to dry out during dry periods. During the survey in August 2010 the creek was flowing and the area consisted of small runs and riffles (Photograph 14.20).

The upstream crossing of Larcom Creek (stream order 3) will result in the bisecting of approximately 35 m of riparian vegetation (dominated by *M. viminalis*), and a large, deep, permanent pool that supports macrophyte beds (Photograph 14.21).

Despite the disturbed nature of the riparian zone and trailing vegetation at the proposed downstream crossing, this region of the watercourse is rich in macrophyte beds which contain *Potamogeton crispus* (Curly Pondweed) and *Ottelia ovalifolia* (Swamp Lily). The Larcom Creek crossing is considered to have a moderate to high aquatic value, and is likely to be an important local refugia habitat for aquatic and terrestrial fauna during dry periods.

Both Larcom Creek crossings have the potential to contain suitable habitat for aquatic species such as the Platypus and possibly the White-throated snapping turtle as it is known to inhabit all of the surrounding catchments. The Fitzroy River turtle is not known to occur within tributaries of the Calliope River. Thus it is unlikely that the permanent pools present within Larcom Creek would be utilised by this species.



Photograph 14.20 Looking upstream towards the Mainland GTP RoW crossing on Larcom Creek (Mount Alma Road)



Photograph 14.21 Mainland GTP RoW crossing location on Larcom Creek

Stream flows

The Fitzroy Basin is characterised by large variations in river flows. Most of the region's rainfall occurs from October to April, causing most stream flows to occur in summer. Prolonged dry periods in the winter result in ephemeral characteristics in many of the key watercourses.

Figure 14.4 details mean monthly flows for various watercourses found within close proximity to the Mainland GTP RoW.

Analysis of the data indicates large seasonal variations in flow, with notable high flows occurring between the months of October and April. The watercourses with the highest flows are the Dawson River (d/s) and Calliope River, with little flow occurring in Bell Creek. This is consistent with their respective upstream catchment sizes (URS 2009).

Flood hydrology

Due to the significant length of the Mainland GTP (approximately 420 km), the assessment of existing flood characteristics focused on major watercourses, where significant environmental risk could occur from inappropriate design or construction. A desktop analysis identified twenty four (24) key watercourse crossing locations.

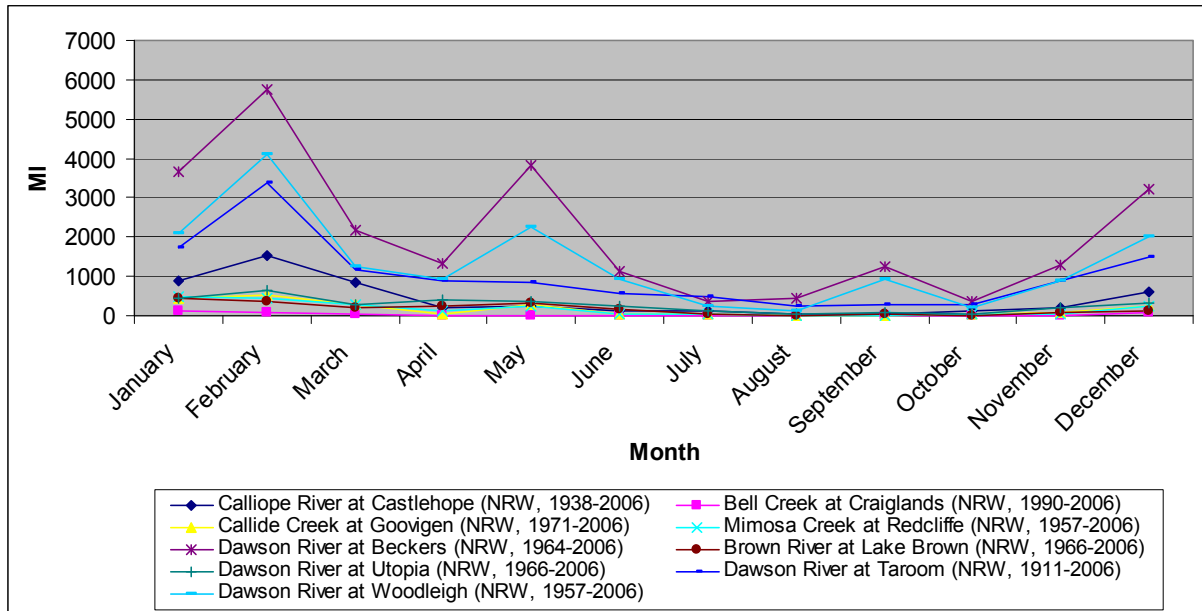


Figure 14.4 Mean monthly flows

As part of the EIS, for each of the 24 key watercourse crossings, hydrological estimates were undertaken using either regional flood frequency regression equations (IEAust, 1987) or the Rational Method based on Weeks (1991). Design peak flows were derived for a range of average recurrence intervals (ARI) using the appropriate method and are summarised in Table 14.3 below.

To approximate the flood depths at each watercourse crossing, a basic hydraulic assessment of the 24 key watercourse crossing locations was undertaken using industry accepted software (HEC-RAS v3). The results are summarized below in Table 14.3 below.

Table 14.3 Predicted peak flows and depths at watercourse crossing locations

No	Watercourse name	Catchment Area (km ²)	Predicted peak flows at crossings			Predicted flood depths at crossings		
			2yr ARI Peak Flow (m ³ /s)	10yr ARI Peak Flow (m ³ /s)	100yr ARI Peak Flow (m ³ /s)	2yr ARI Depth (m)	10yr ARI Depth (m)	100yr ARI Depth (m)
1	Larcom Creek	278	43	404	1,657	1.5	4.2	6.7
2	Calliope River	489	51	427	1,686	1.6	3.3	6.0
3	Bell Creek	46	61	142	339	1.6	2.7	4.4
4	Callide Creek	763	59	447	1,708	1.9	5.4	6.5
5	Kroombit Creek	2,340	82	500	1,767	1.7	3.5	5.2
6	Banana Creek	700	57	443	1,704	2.4	3.8	5.2
7	Kianga Creek	551	53	432	1,692	2.4	2.9	3.6
8	Dawson River (d/s)	32,735	448	1,200	2,354	8.1	12.6	16.5
9	Mimosa Creek	3,230	90	516	1,784	1.7	4.3	6.4
10	Conciliation Creek (d/s)	946	62	456	1,720	2.4	3.7	5.1

No	Watercourse name	Catchment Area (km ²)	Predicted peak flows at crossings			Predicted flood depths at crossings		
			2yr ARI Peak Flow (m ³ /s)	10yr ARI Peak Flow (m ³ /s)	100yr ARI Peak Flow (m ³ /s)	2yr ARI Depth (m)	10yr ARI Depth (m)	100yr ARI Depth (m)
11	Zamia Creek (d/s 1)	2,590	85	505	1,772	2.4	3.5	4.8
12	Zamia Creek (d/s 2)	2,075	79	494	1,761	2.4	4.5	5.1
13	Zamia Creek (u/s 2)	2,025	79	492	1,759	1.6	2.3	3.3
14	Zamia Creek (u/s 1)	1,966	78	491	1,758	2.2	4.1	5.0
15	Conciliation Creek (u/s)	11	22	51	121	1.3	1.5	1.8
16	Clematis Creek	781	59	448	1,710	3.9	11.1	20.5
17	Brown River	1,041	64	461	1,724	2.8	3.4	4.1
16	Spring Creek	60	27	346	1583	2.0	5.5	6.3
19	Arcadia Creek	377	47	416	1,673	2.9	4.5	6.9
20	Dawson River (u/s)	1,134	117	612	1,990	8.2	14.9	18.5
21	Sardine Creek	667	56	441	1,702	3.4	7.4	12.6
22	Baffle Creek (u/s)	462	81	512	1,903	3.6	6.9	9.2
23	Baffle Creek (d/s)	654	94	549	1,936	3.5	6.5	8.9
24	Hutton Creek	2,791	86	509	1,776	1.8	5.6	11.5

Declared catchments

With regard to Environmentally Sensitive Areas (ESAs) required to be identified as part of the Coal Seam Gas (CSG) Guidelines for preparing an EMP, the Mainland GTP RoW does not intersect any declared catchments (a Category C ESA) as defined under the *Water Act 2000*.

Wetlands and springs

The Directory of Important Wetlands in Australia (DIWA) lists three sites within the broad study area. These have been identified as the Palm Tree and Robinson Creeks; the Boggomoss Springs, and Lake Nuga Nuga. The Mainland GTP RoW crosses none of these designated wetlands directly. However, some potentially affected tributaries feed into the wetlands.

The Palm Tree and Robinson Creeks designated wetland lies within the upstream catchment of the Dawson River. It is the largest designated wetland in the vicinity of the GTP with a total area of 500km². Tributary flows feeding the wetland are not crossed by the GTP and therefore the GTP is not anticipated to impact the wetland.

Within the upstream catchment of the Dawson River lies the DERM designated wetland Boggomoss Springs. Flows from the upper Dawson River, including the two crossings on Baffle Creek, Sardine Creek, Dawson River (downstream) and Hutton Creek appear to feed into the wetland. Although a site assessment of this lake was not undertaken as part of the EIS, it is anticipated that the crossing locations will not impact on this wetland should appropriate sediment and pollution controls be implemented.

The downstream reaches of the Brown River enter the EPA designated wetland of Lake Nuga Nuga. Upstream of the wetland, crossings are located at Spring Creek and Arcadia Creek. Based on the management measures proposed in the sediment and erosion control plan, it is not envisaged that this wetland will be adversely affected by construction of the GTP.

There are no Ramsar wetlands listed in proximity to the GTP site with the closest being Great Sandy Straight located approximately 250 km to the South East of Gladstone.

It is noted that DERM Referable Wetlands⁴ and their respective trigger areas are located within the RoW. As this Project is exempt from the *Sustainable Planning Regulation 2009*, Referable Wetlands need not be referred to DERM. However, the DERM Guideline 2010 *Preparing an environmental management plan for coal seam gas activities* defines Referable Wetlands as Category C Environmentally Sensitive Areas (ESAs). Based on this, Referable Wetlands as ESA's are to be addressed. Details regarding Referable Wetlands are provided below.

The Referable Wetlands are made up of Wetland Management Areas (WMAs) and Wetland Protection Areas (WPAs). Several WPAs are located within the RoW as illustrated in Figures 14.5 (1 to 14). A brief description of these wetlands is provided in Table 14.4.

Table 14.4 Details of wetlands located within the GTP corridor

Approximate KP Point (km)	Referable Wetland type	DERM Wetland System type	Approximate length of disturbance (m)
3.25	-	Areas that might include wetlands 1-50% (1 – 50%)	160
20.25	-	1 - 50%	80
30.00	-	1 - 50%	3300
62.25	-	1 - 50%	80
105.00	-	1 - 50%	300
108.50	-	1 - 50%	130
177.00	WMA	Palustrine waterbody	60
188.00	WMA 100 m buffer ¹	Riverine waterbody	-
190.00	WMA 100 m buffer	Riverine waterbody	-
204.00	WPA 100 m buffer	Palustrine waterbody	-
206.00	WMA	Palustrine waterbody	130
207.50	WMA	Riverine Wetland Regional Ecosystem	320
212.00	WMA 100 m buffer	Riverine waterbody	-
213.50	WMA	Riverine waterbody	100
220.00	WMA	Riverine waterbody/ 1-50%	40/130
234.00	WMA	Riverine waterbody/ 1-50%	120/430
236.75	WMA	Palustrine waterbody	110
240.25	-	Lacustrine waterbody	50
295.00	WMA	Riverine Wetland Regional Ecosystem	130
360.00	WMA	Riverine waterbody	60
361.00	WPA 100 m buffer	Palustrine waterbody	-

Table Notes ¹GTP passes through 100 m buffer around Referable Wetland only but not the actual wetland. This buffer acts as a trigger mechanism for Referable Wetlands to DERM.

A search of DERM's Queensland Wetland Data System indicates that 21 Wetland Systems are located along the GTP corridor. Details of these wetland systems are listed in Table 14.4 and their locations are depicted in Figures 14.6 (1 to 14).

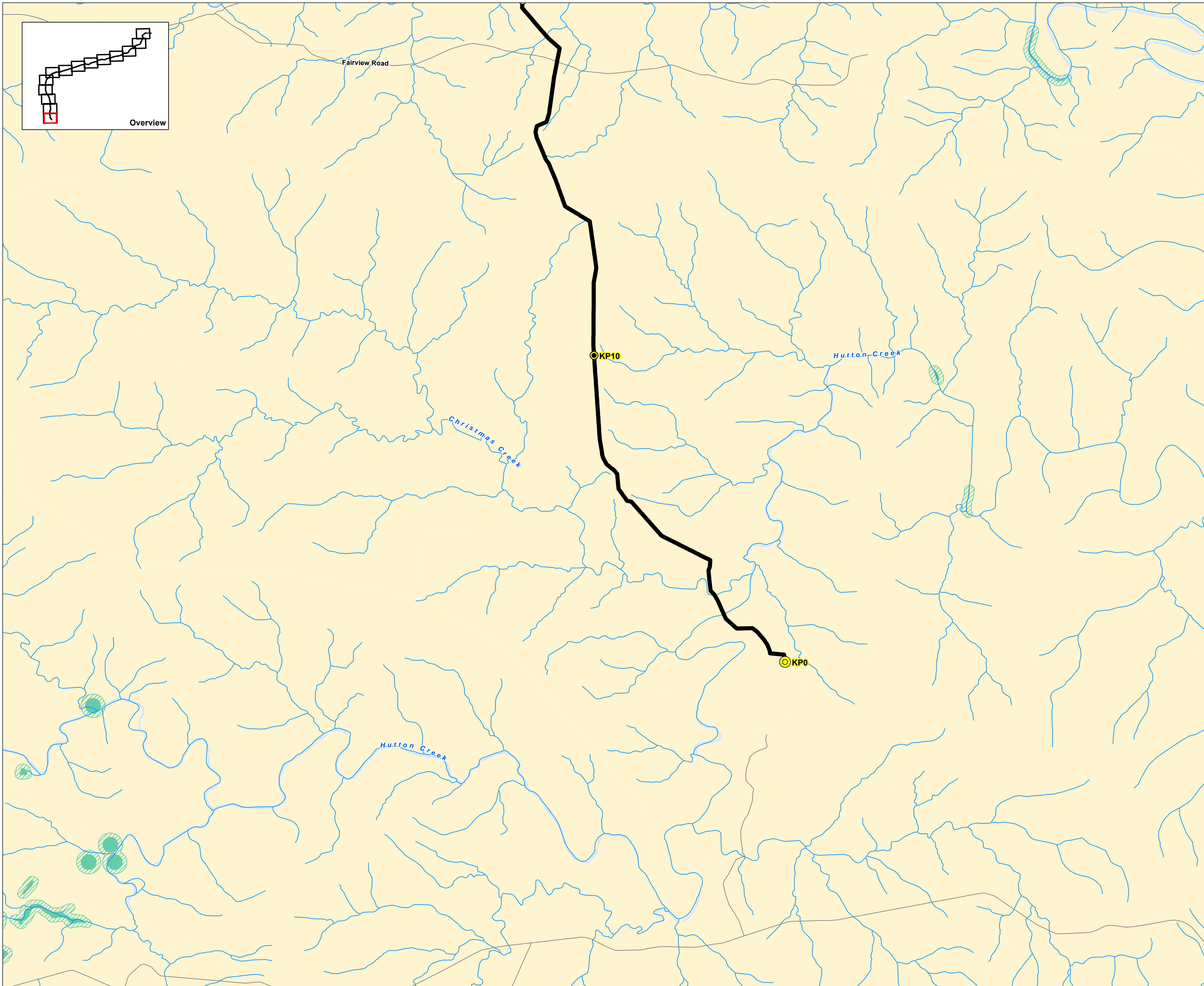
Although the location of the GTP has been designed to avoid most of the WMAs, WPAs and DERM Wetland Systems there are locations where contact between the GTP and wetland areas is

⁴ A referable wetland is an area identified as a wetland on the *Map of Referable Wetlands*. The current Map of Referable Wetlands is a tool used to trigger DERM's concurrence and advice role under the Sustainable Planning Act 2009 (Qld).



Mainland GTP EM Plan

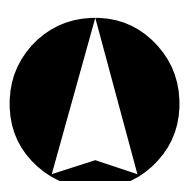
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 - Mainland GTP EM Plan
 - Marine Crossing GTP EM Plan
 - Curtis Island GTP EM Plan
- Kilometre Post Distance Marker
 - 50km
 - 10km
- Referable Wetlands
 - Wetland Management Area Trigger
 - Wetland Management Area
 - GBR Wetland Protection Area trigger area
 - GBR Wetland Protection Area HES wetland
- Watercourse



Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Water Bodies and Wetland Regional Ecosystems:
 Queensland Wetland Data v1.2, Department of
 Environment and Resource Management, 2008.
 Watercourses: Department of Environment and
 Resource Management, 2009.

Referable Wetlands and Watercourses
Figure 14.5 (Page 1 of 14)

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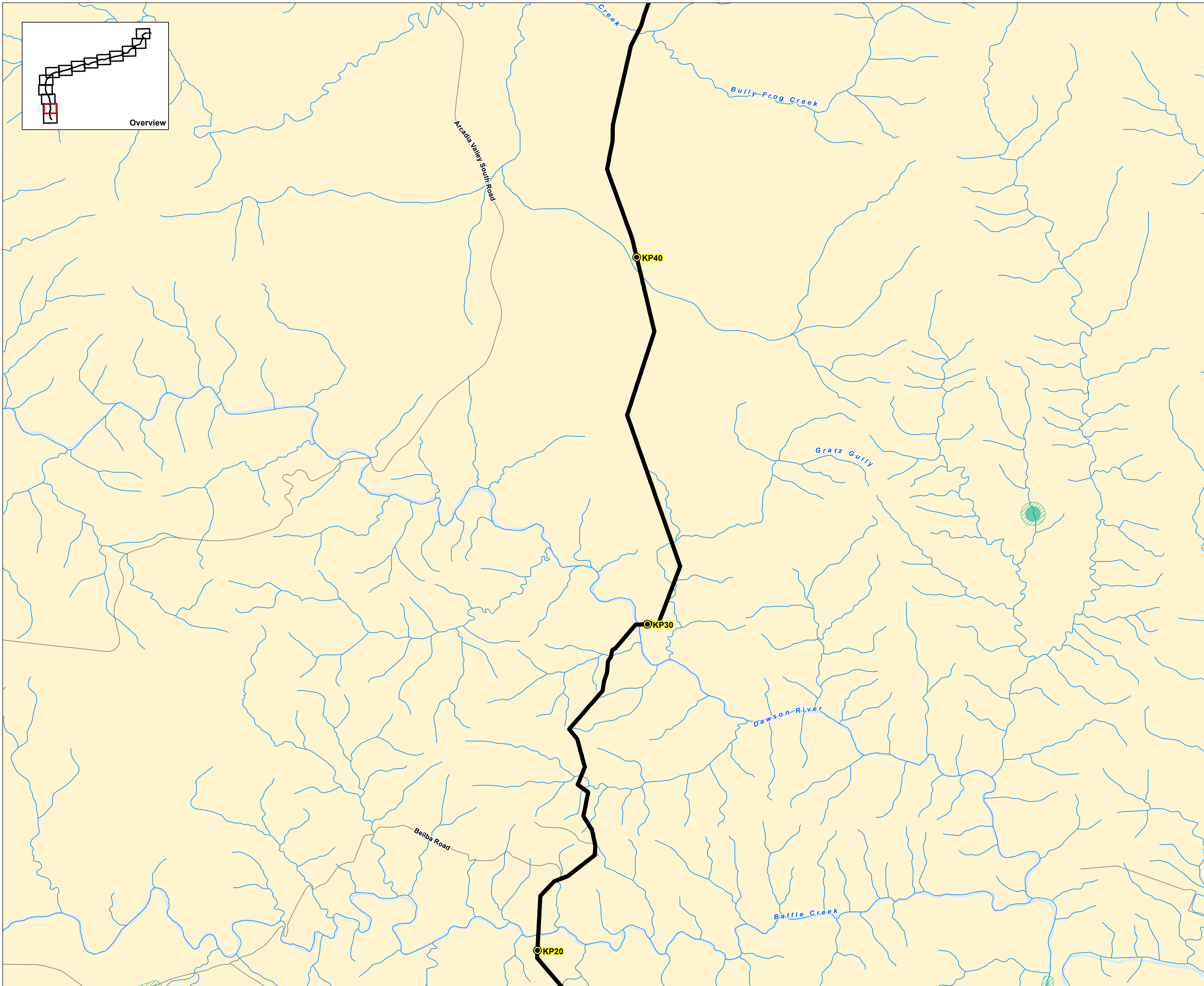
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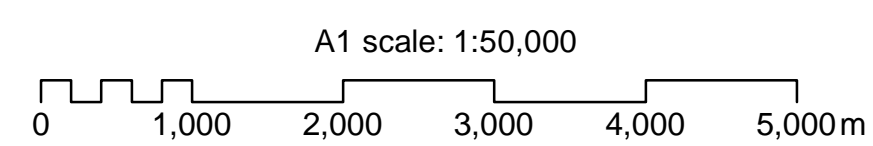
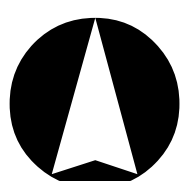
Mainland GTP EM Plan

- Gas Transmission Pipeline (GTP)
- Mainland GTP EM Plan
 - Marine Crossing GTP EM Plan
 - Curtis Island GTP EM Plan
- Kilometre Post Distance Marker
- 50km
 - 10km
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 - GBR Wetland Protection Area HES wetland
- Watercourse



Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Water Bodies and Wetland Regional Ecosystems:
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 Watercourses: Department of Environment and
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**Referable Wetlands and
 Watercourses**
Figure 14.5 (Page 2 of 14)





Mainland GTP EM Plan

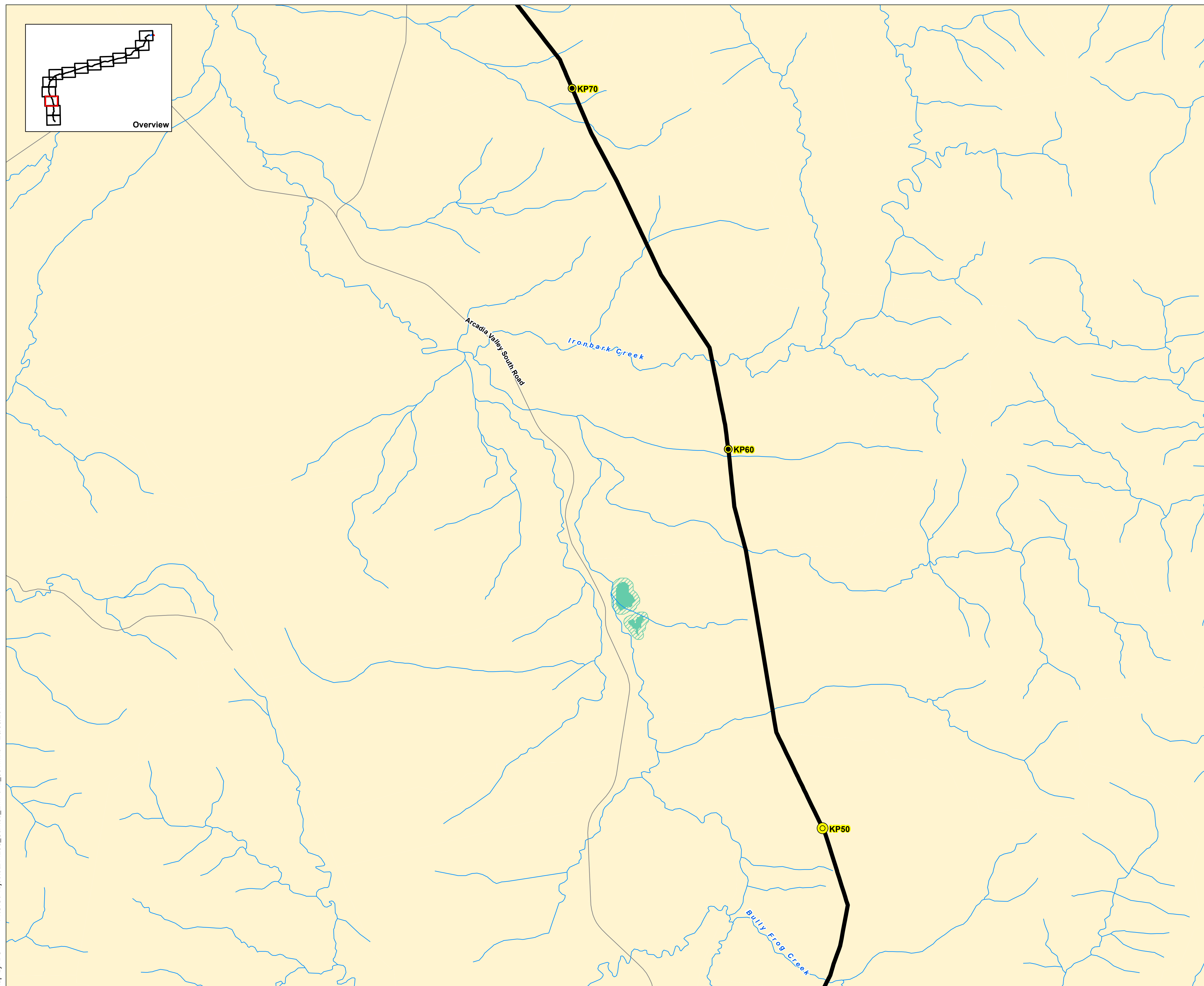
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Source:
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**Referable Wetlands and
 Watercourses**
Figure 14.5 (Page 3 of 14)

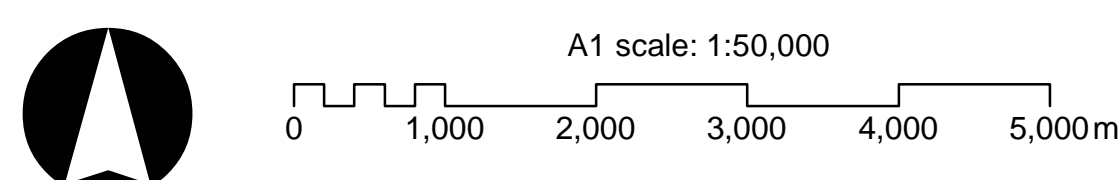
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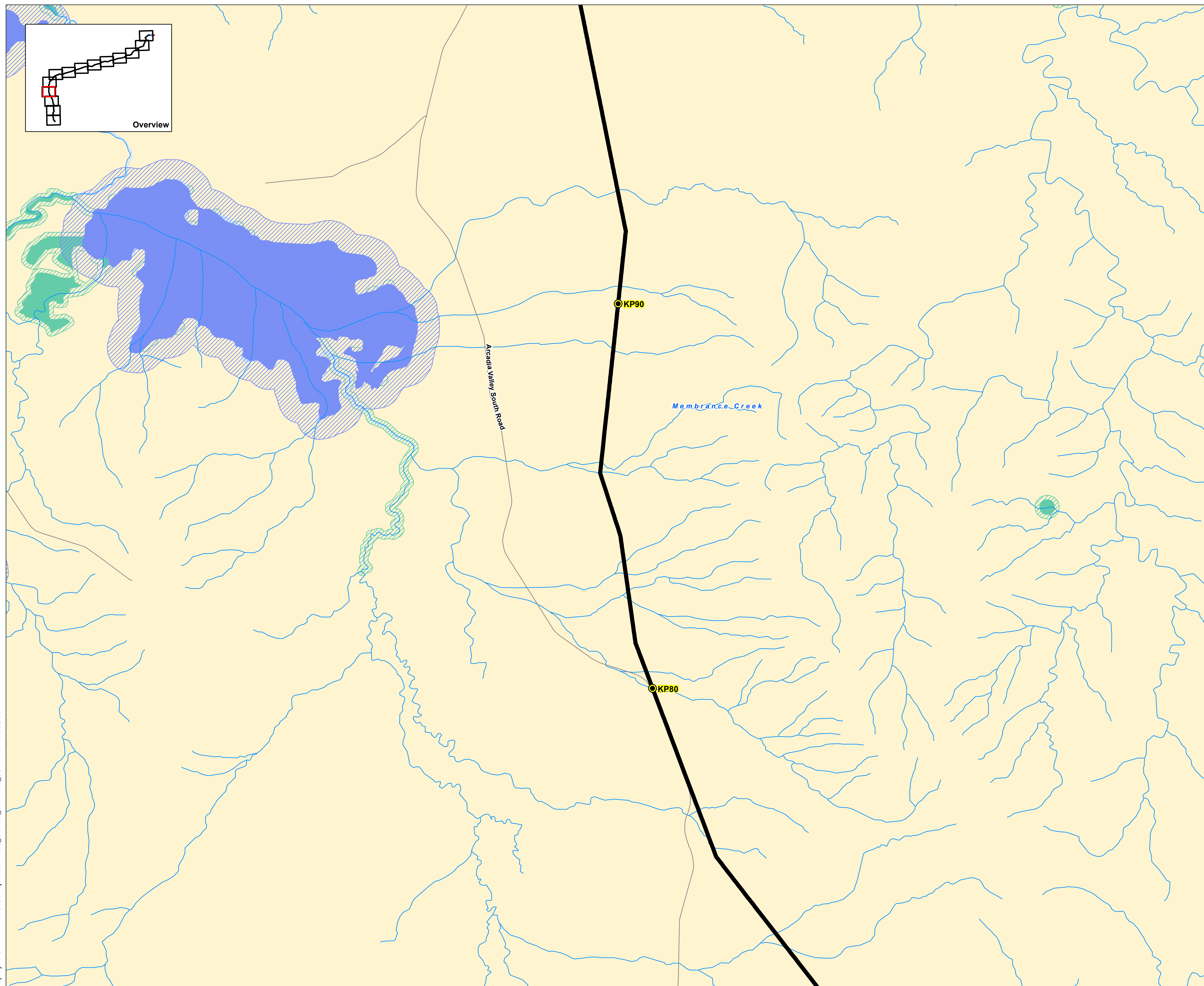


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Mainland GTP EM Plan

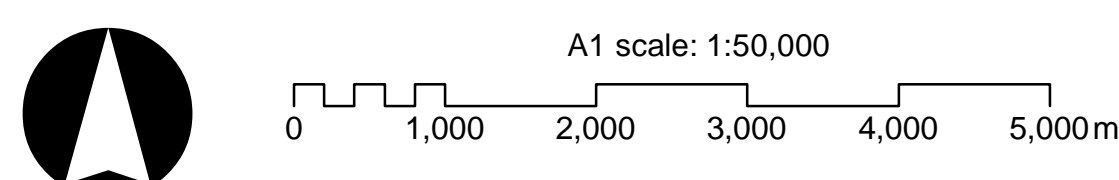
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 - Wetland Management Area
 - GBR Wetland Protection Area trigger area
 - GBR Wetland Protection Area HES wetland
- Watercourse



Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Water Bodies and Wetland Regional Ecosystems:
 Queensland Wetland Data v1.2, Department of
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**Referable Wetlands and
Watercourses**
Figure 14.5 (Page 4 of 14)

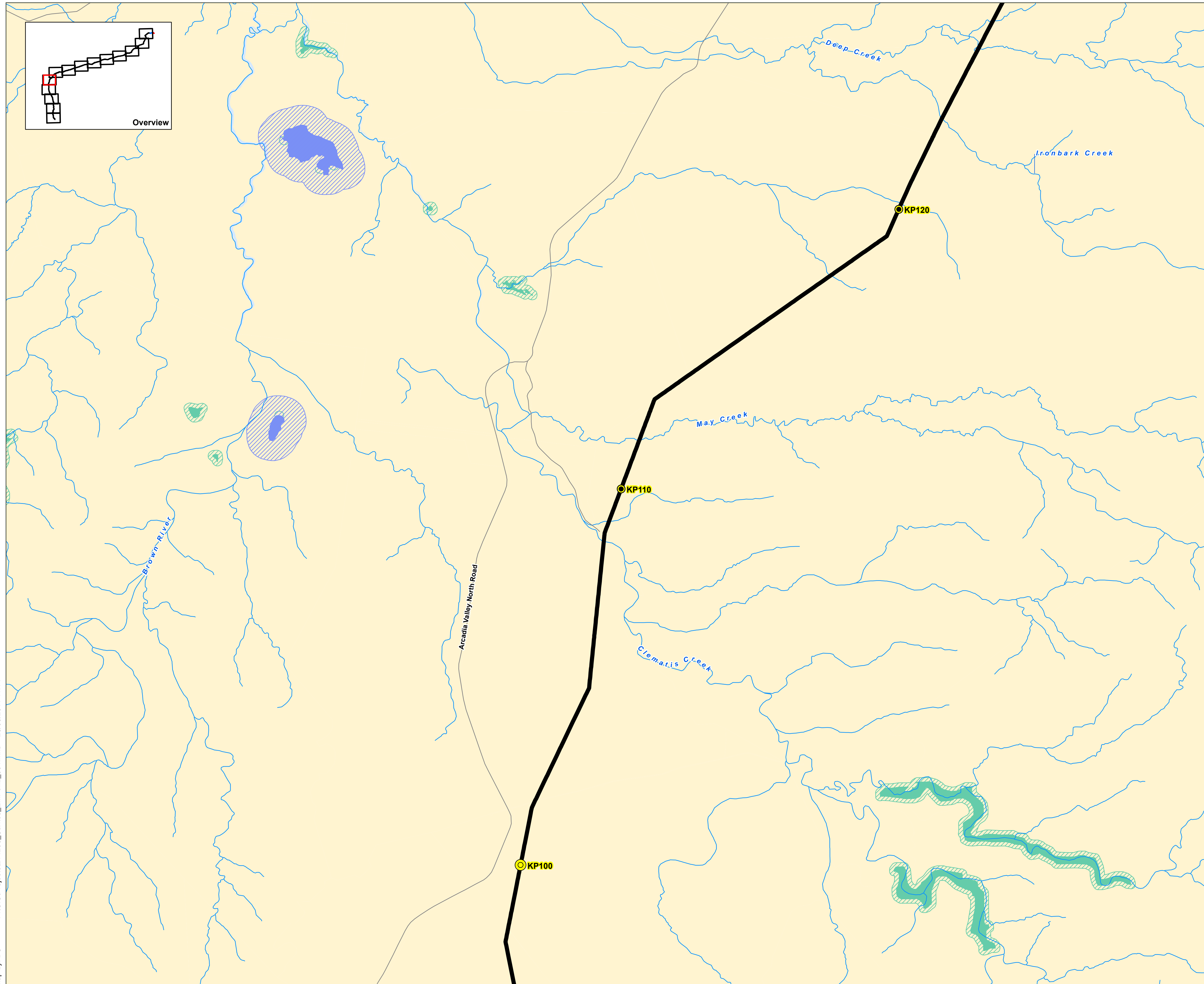
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 Map by: BS





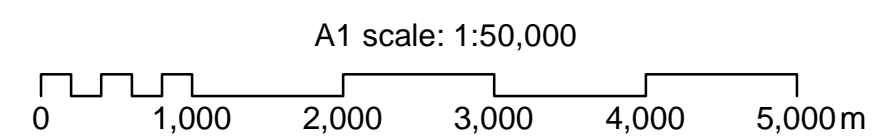
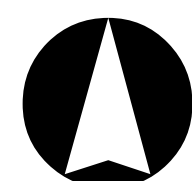
Mainland GTP EM Plan

- Gas Transmission Pipeline (GTP)
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 - Curtis Island GTP EM Plan
- Kilometre Post Distance Marker
 - 50km
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**Referable Wetlands and
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Figure 14.5 (Page 5 of 14)

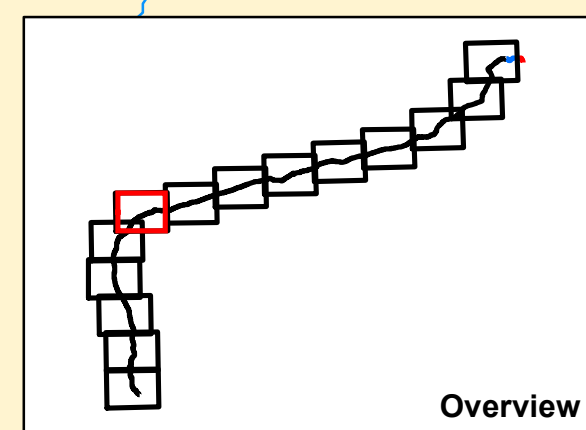
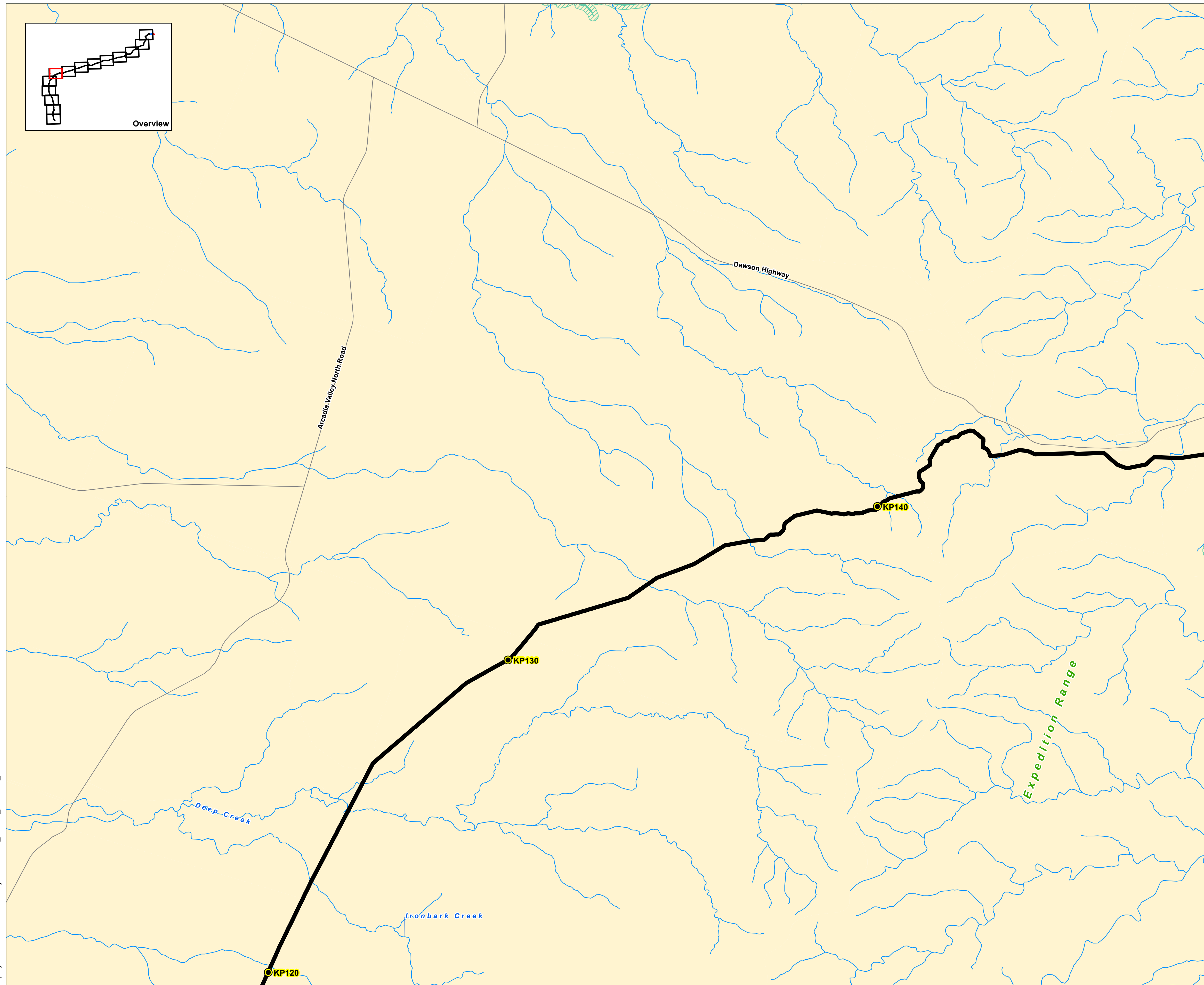


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Mainland GTP EM Plan

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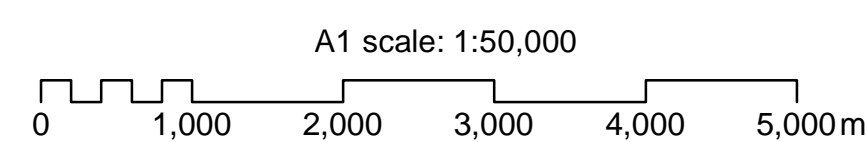
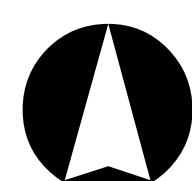


Overview

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Map by: BS

Source:
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**Referable Wetlands and
Watercourses**
Figure 14.5 (Page 6 of 14)



GLNG No: 3381-40-0429
 Coordinate system: GCS GDA 1994

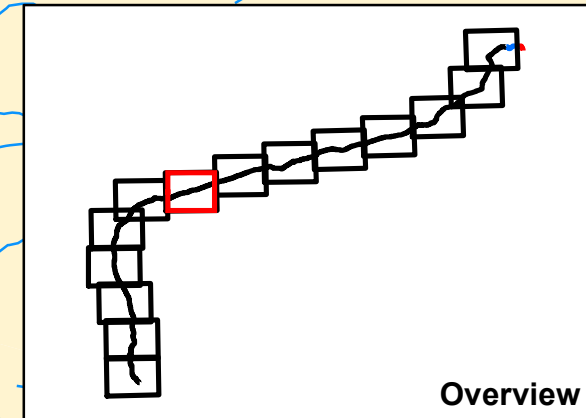
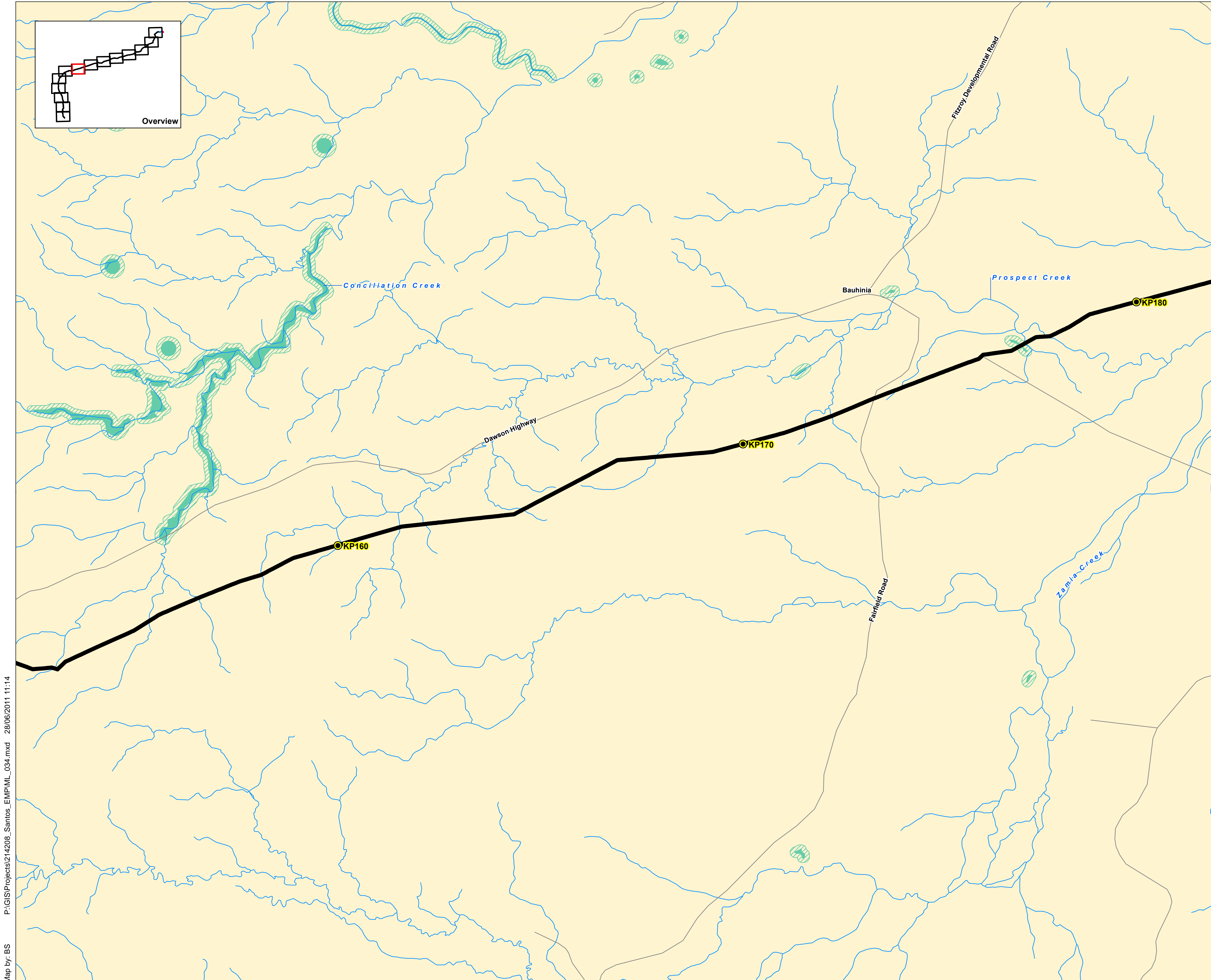
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Mainland GTP EM Plan

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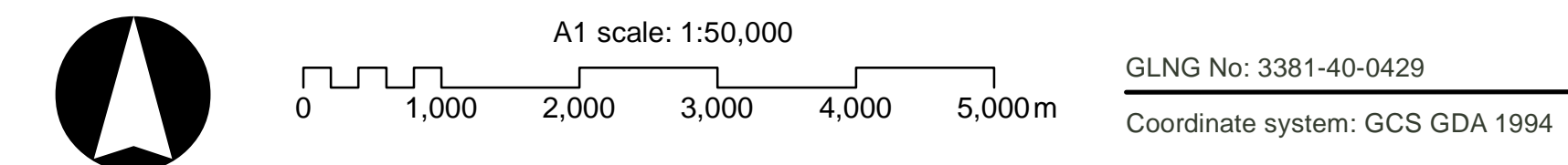


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**Referable Wetlands and
Watercourses**
Figure 14.5 (Page 7 of 14)

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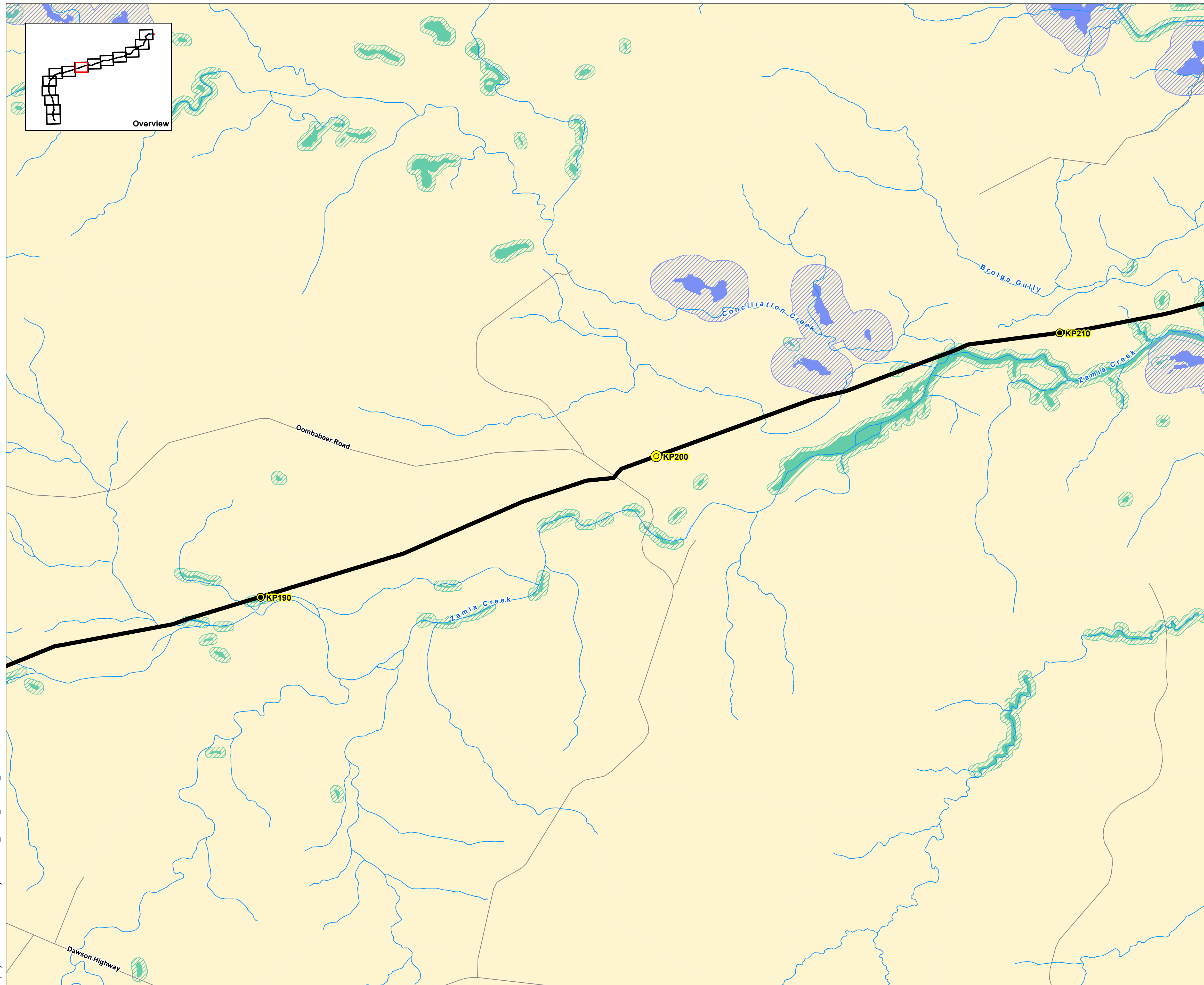
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Mainland GTP EM Plan

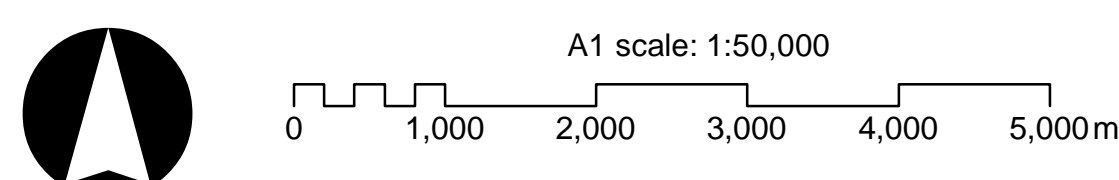
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**Referable Wetlands and
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Figure 14.5 (Page 8 of 14)

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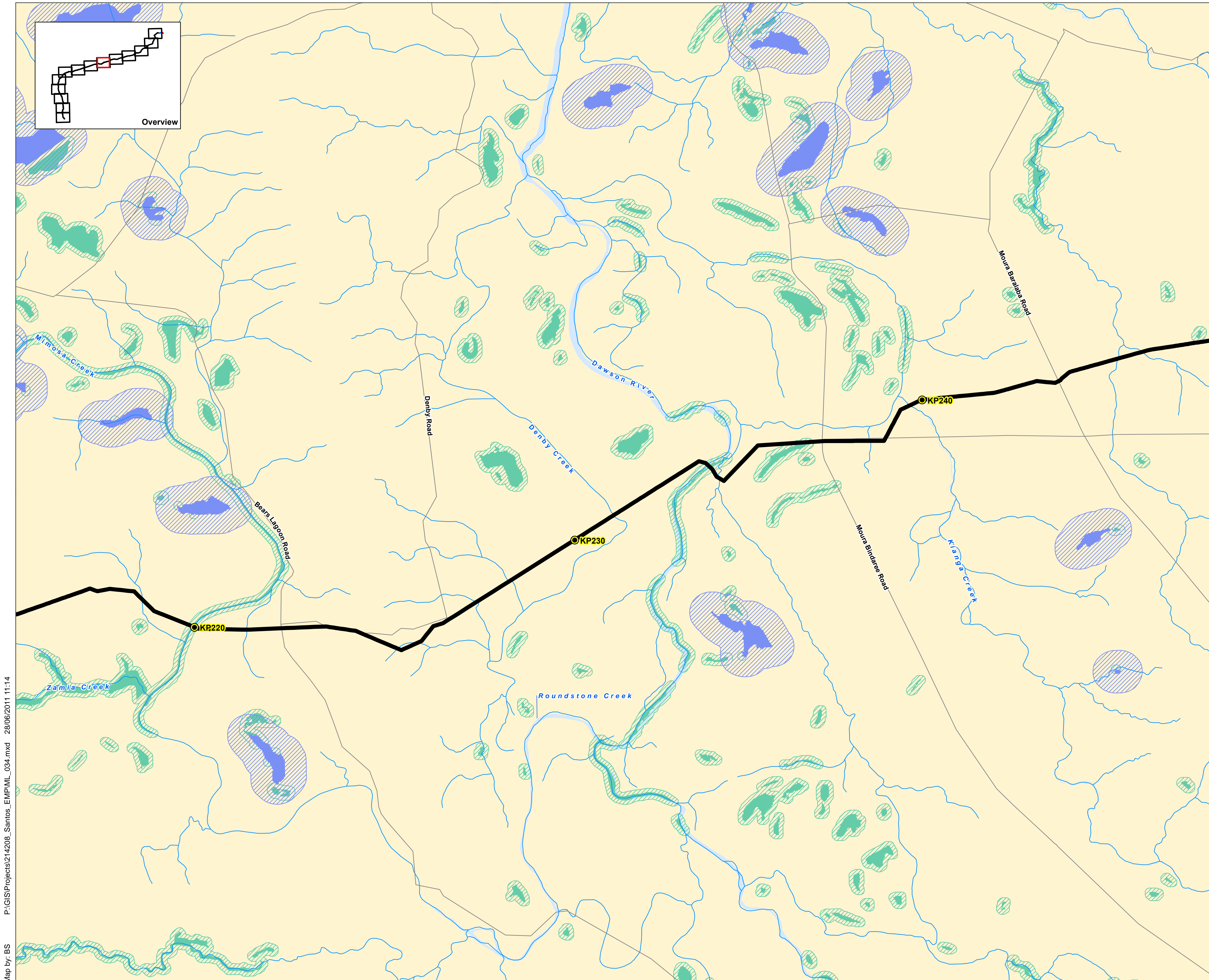


GLNG No: 3381-40-0429
 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

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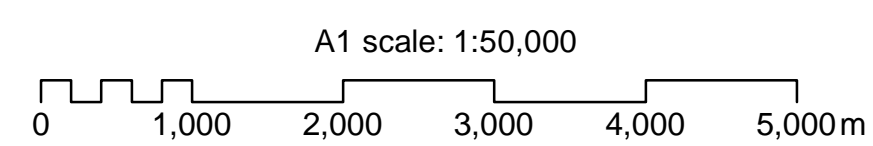
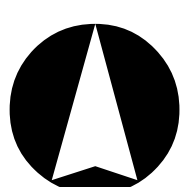


Source:
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**Referable Wetlands and
 Watercourses**
Figure 14.5 (Page 9 of 14)

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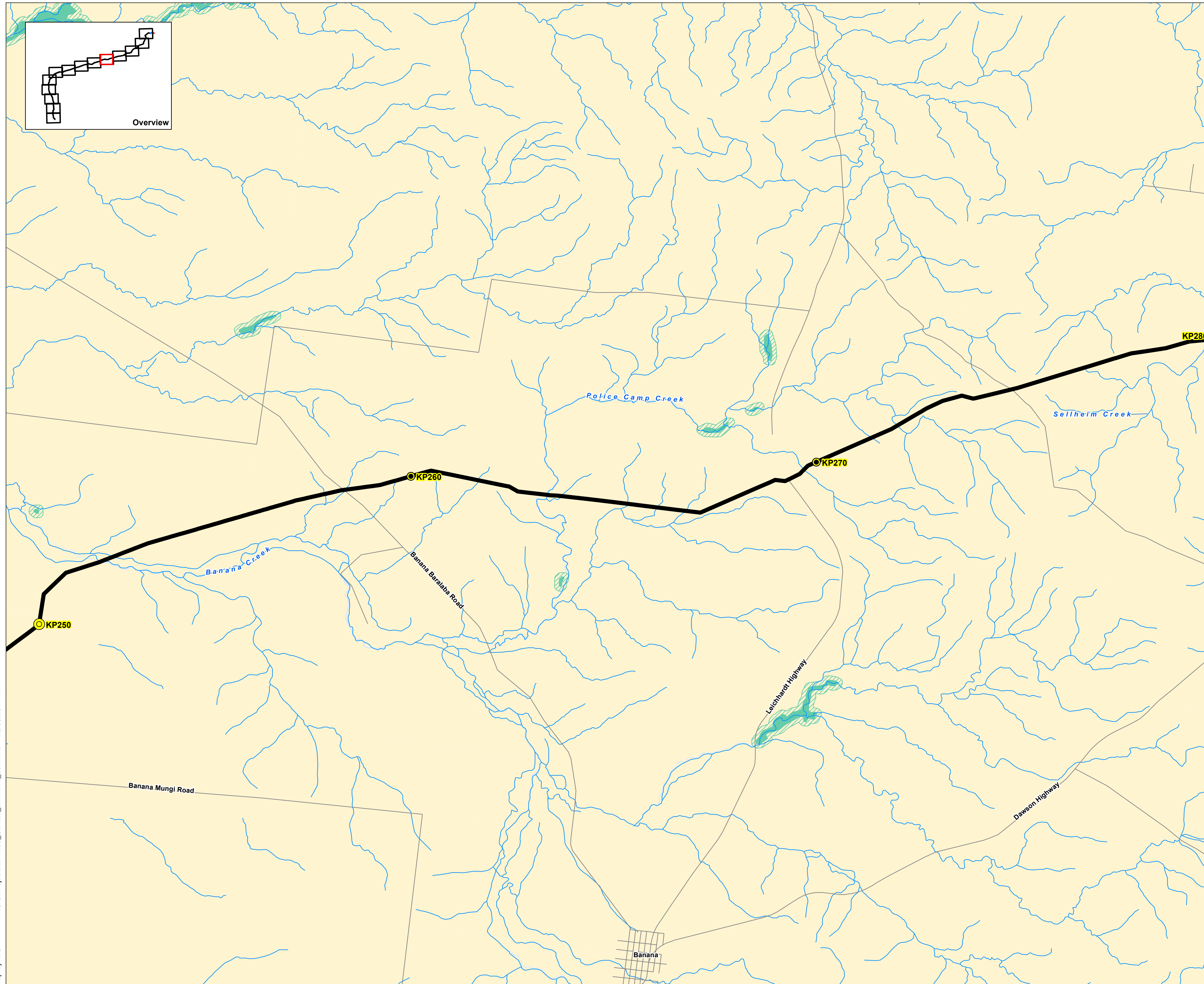
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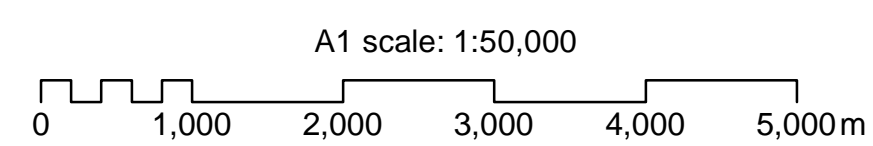
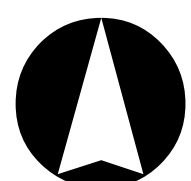
Mainland GTP EM Plan

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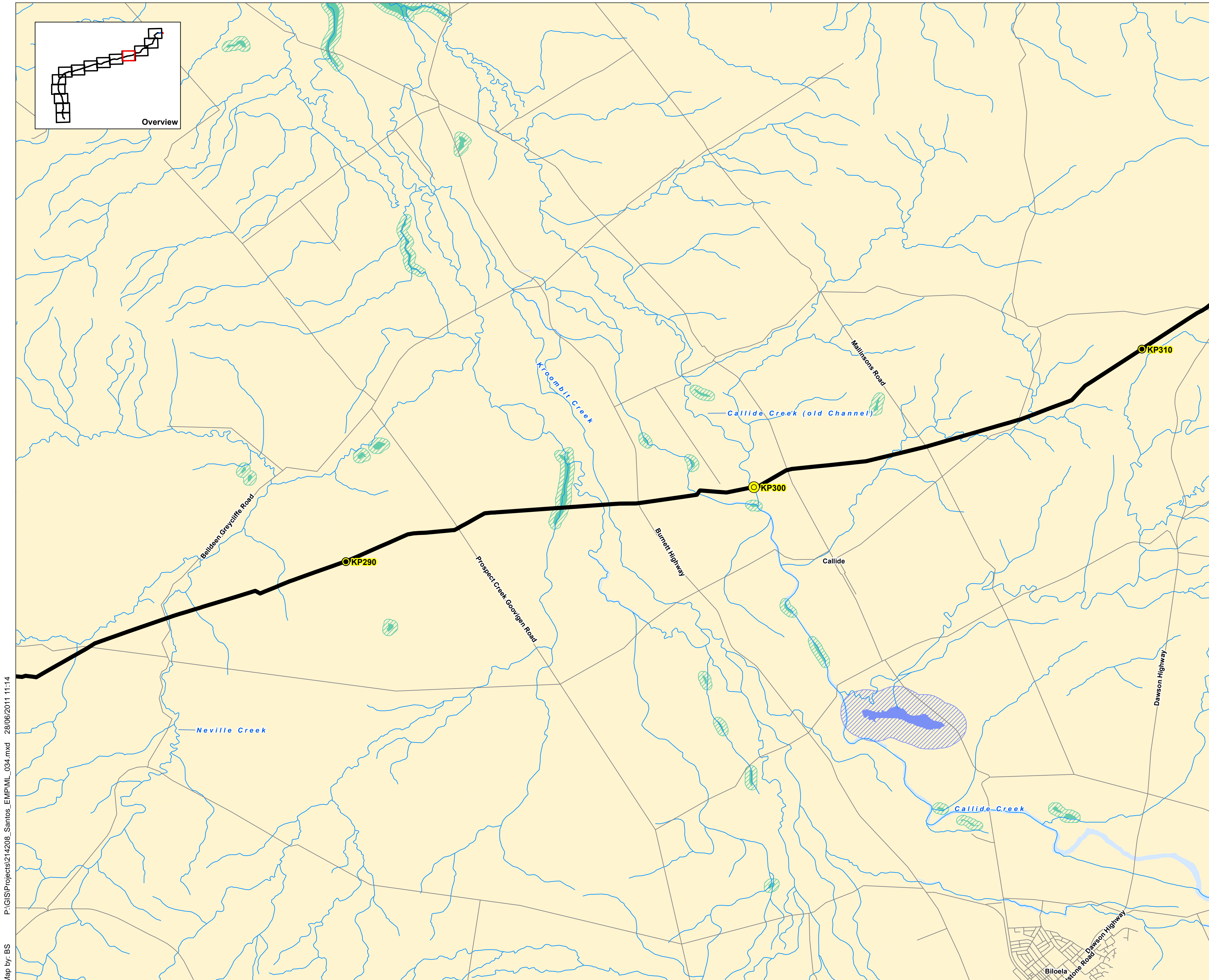
**Referable Wetlands and
Watercourses**
Figure 14.5 (Page 10 of 14)





Mainland GTP EM Plan

- Gas Transmission Pipeline (GTP)
 - Mainland GTP EM Plan
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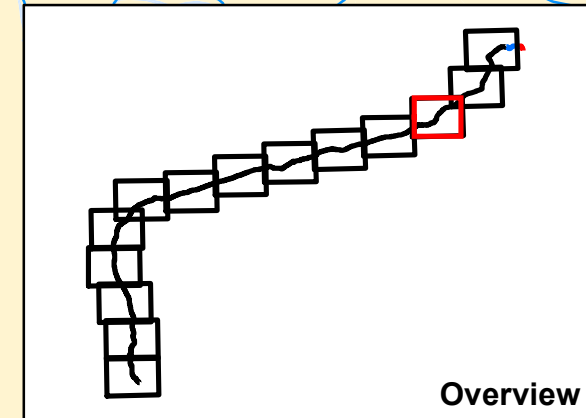
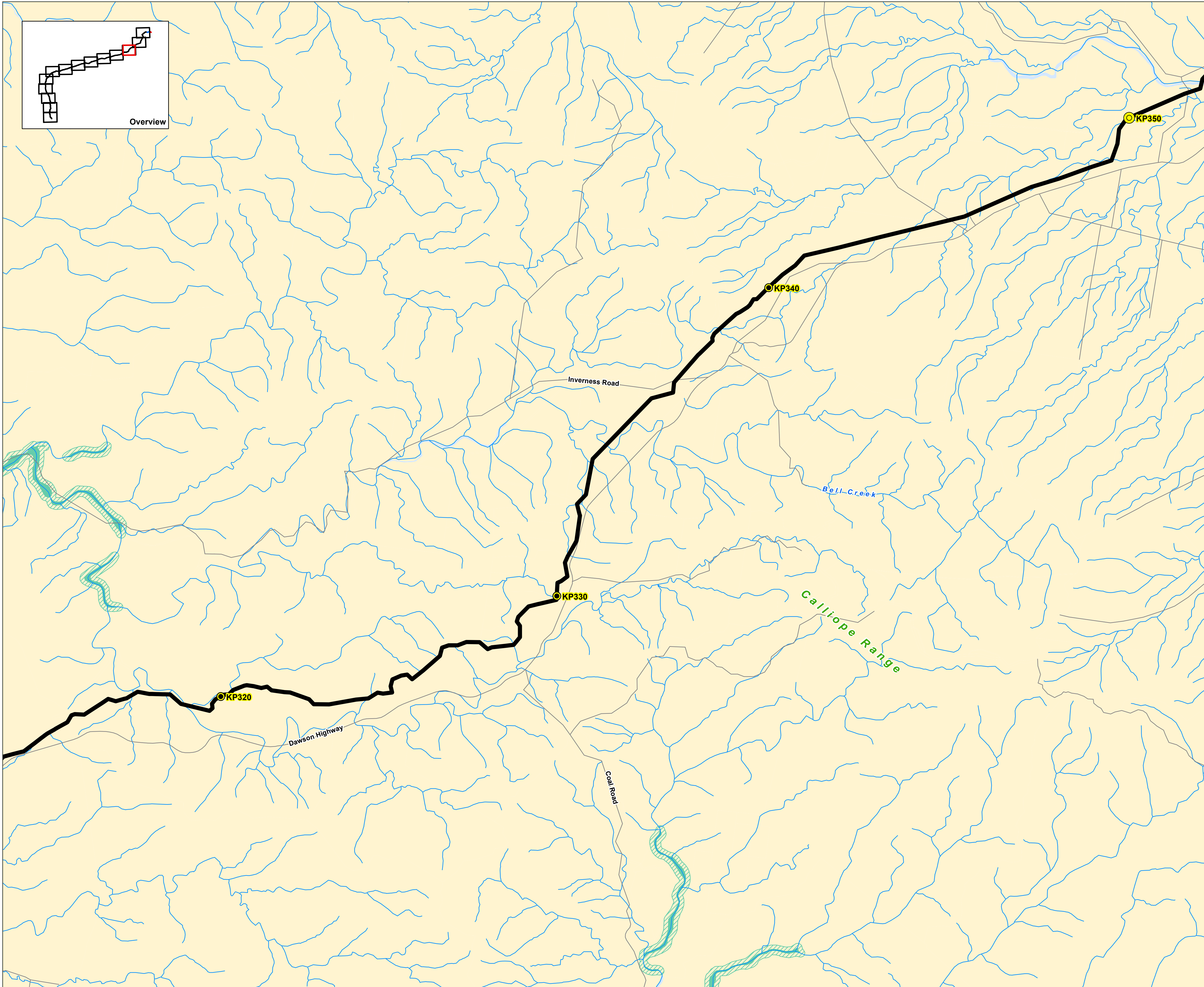
Referable Wetlands and Watercourses
Figure 14.5 (Page 11 of 14)

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 Map by: BS



Mainland GTP EM Plan

- Gas Transmission Pipeline (GTP)
 - Mainland GTP EM Plan
 - Marine Crossing GTP EM Plan
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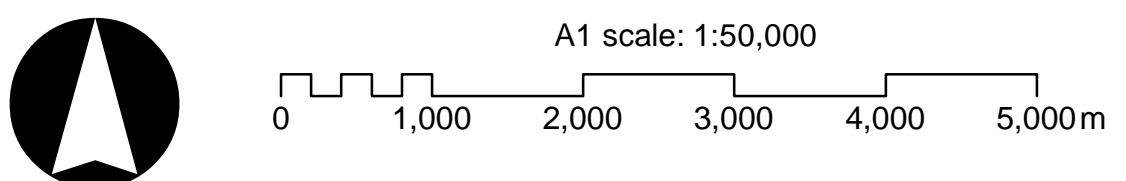


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Referable Wetlands and Watercourses
Figure 14.5 (Page 12 of 14)

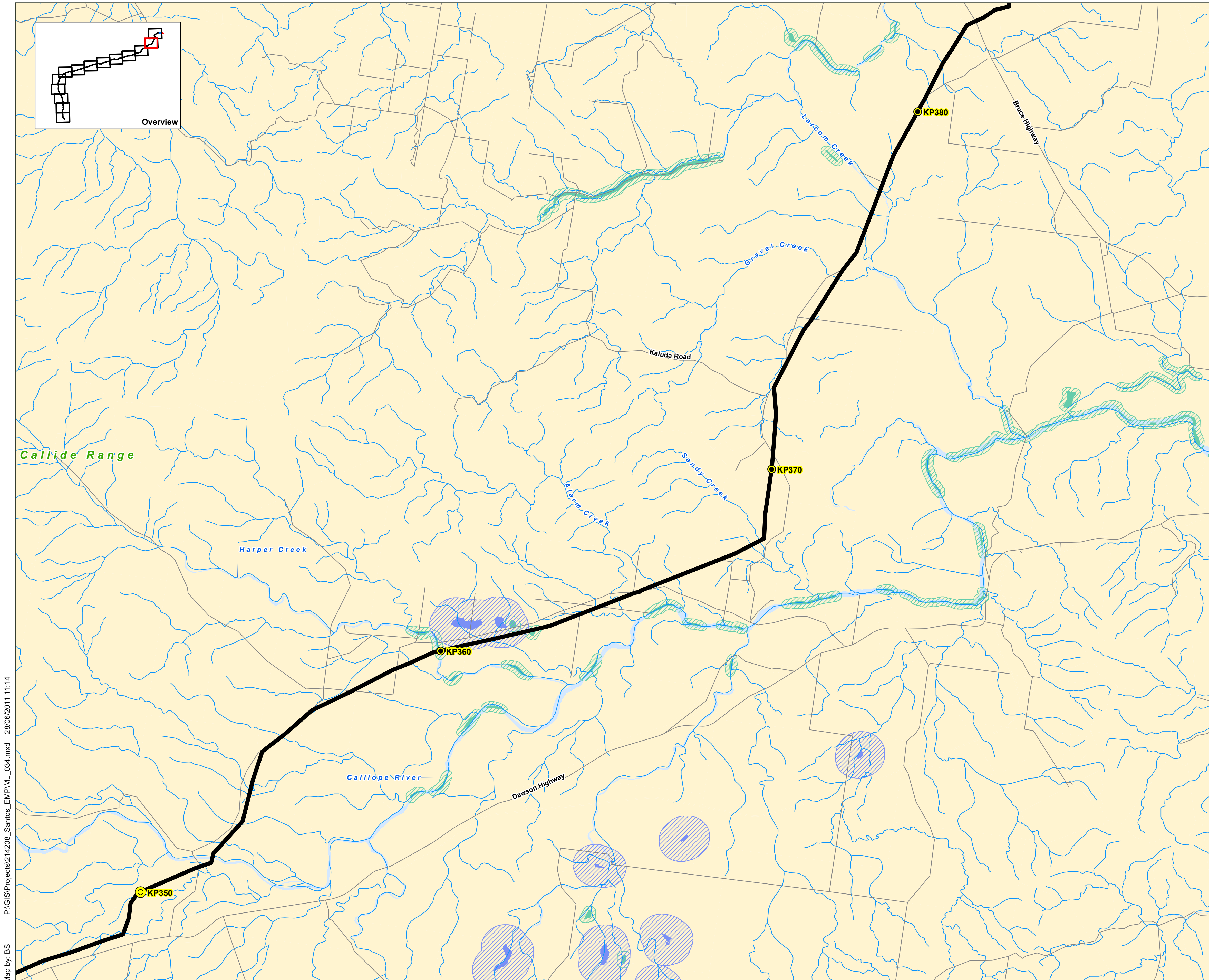


GLNG No: 3381-40-0429
 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

- Gas Transmission Pipeline (GTP)
- Mainland GTP EM Plan
 - Marine Crossing GTP EM Plan
 - Curtis Island GTP EM Plan
- Kilometre Post Distance Marker
- 50km
 - 10km
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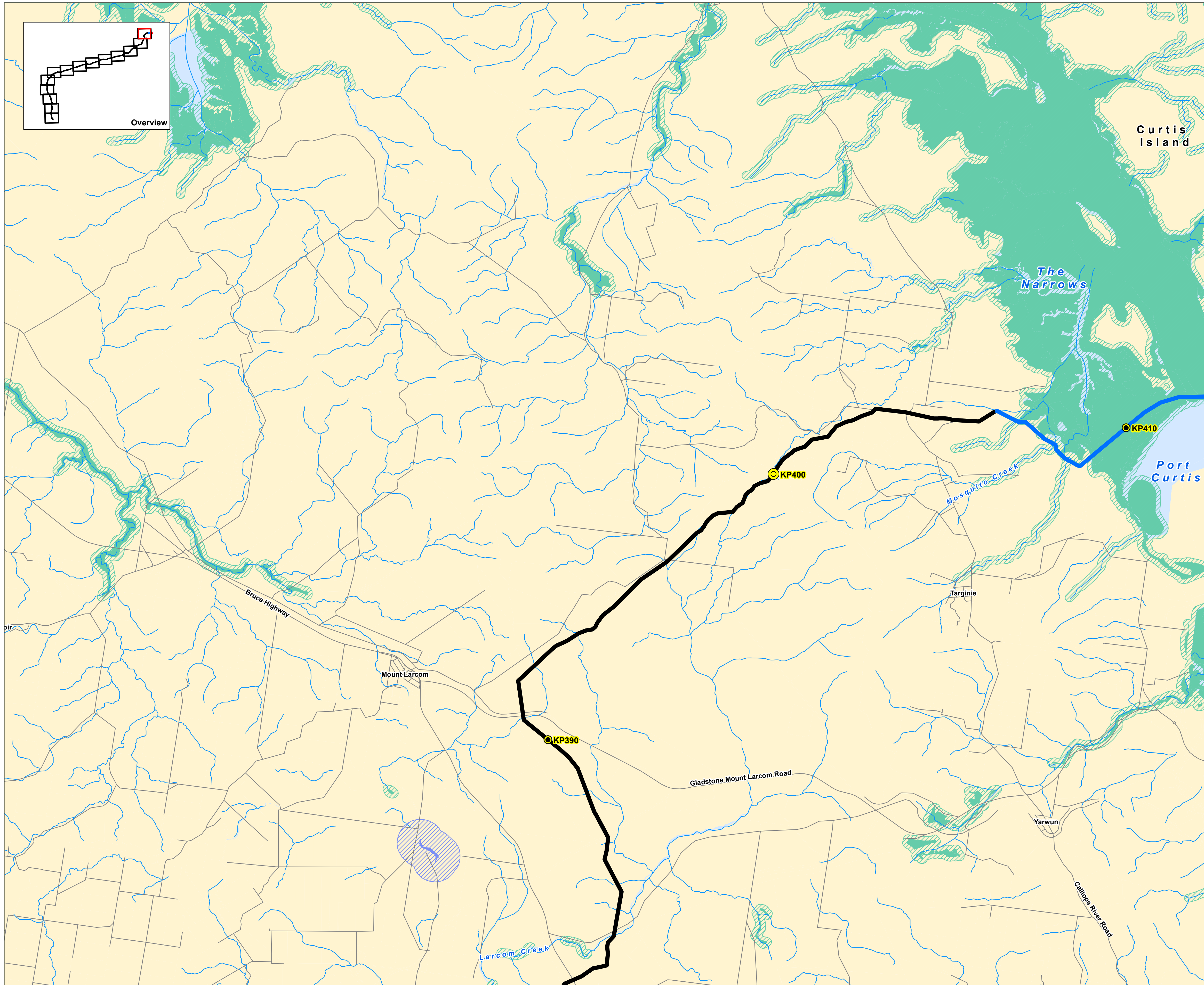
Referable Wetlands and Watercourses
Figure 14.5 (Page 13 of 14)

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 Map by: BS



Mainland GTP EM Plan

- Gas Transmission Pipeline (GTP)
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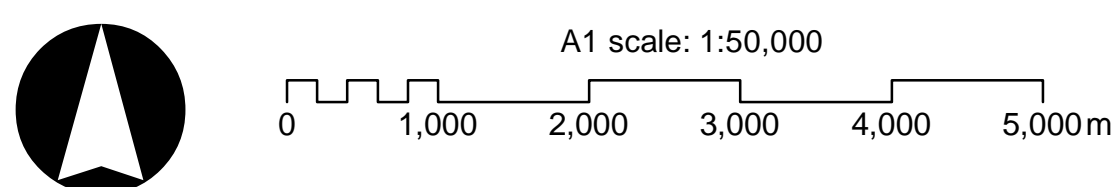
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**Referable Wetlands and
 Watercourses**
Figure 14.5 (Page 14 of 14)

Date: 28/06/2011

Version: c

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 Map by: BS



GLNG No: 3381-40-0429
 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 50km
- 10km

Wetland Regional Ecosystem

- Marine
- Estuarine
- Riverine
- Lacustrine
- Palustrine

Water Body

- Marine
- Estuarine
- Lacustrine
- Riverine
- Palustrine

Areas that May Include Wetlands

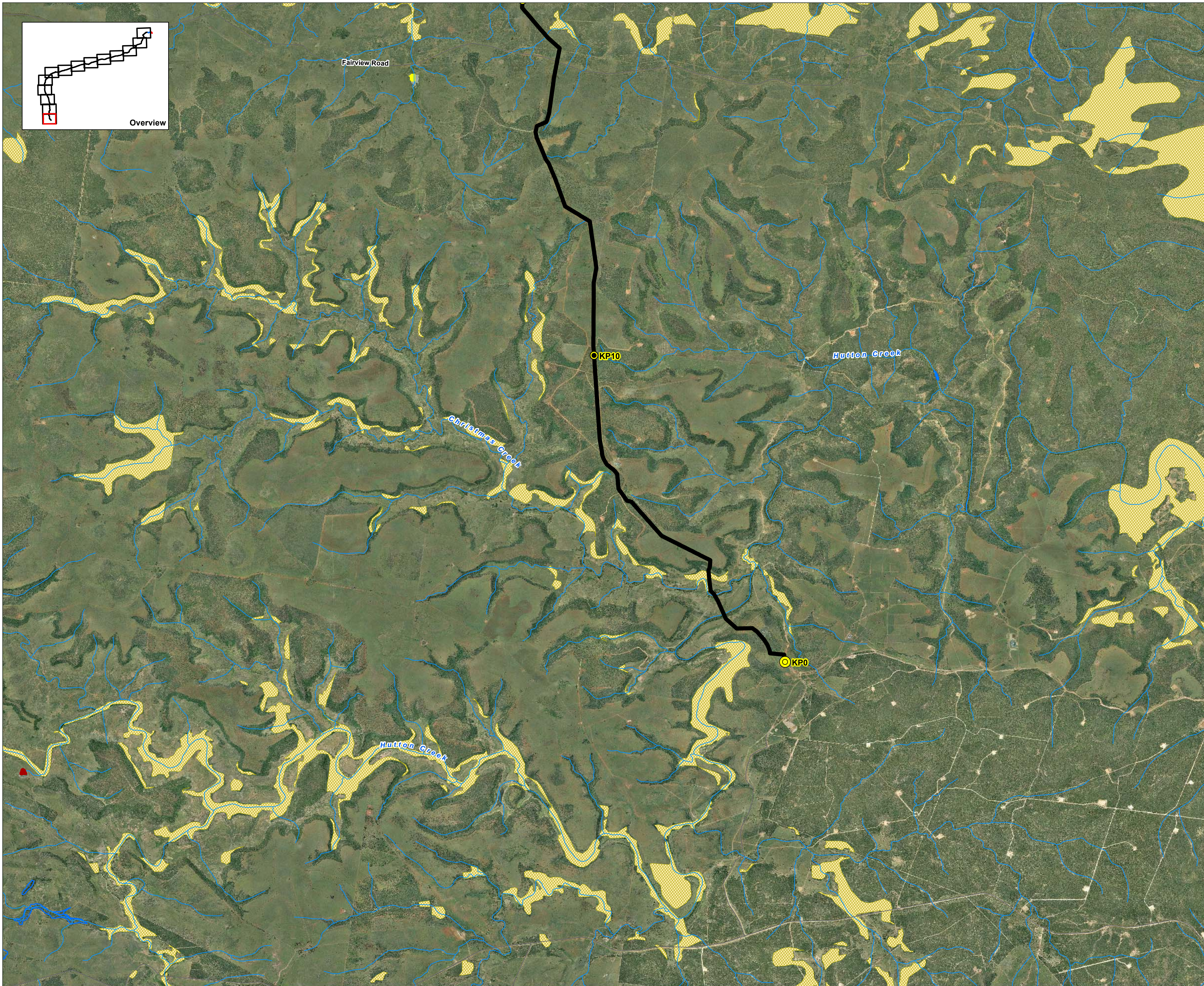
- 51-80% wetland
- 1-50% wetland
- Watercourse

Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Water Bodies and Wetland Regional Ecosystems:
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Wetland Systems
Figure 14.6 (Page 1 of 14)

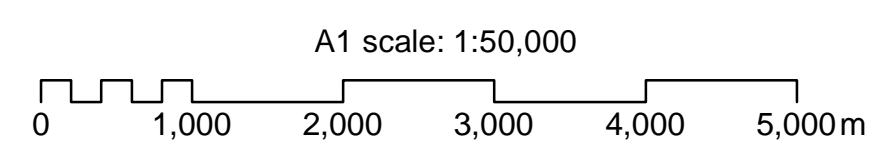
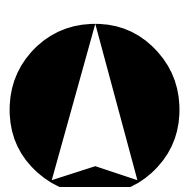
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Version: b



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Map by: BS



GLNG No: 3381-40-0430
 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 50km
- 10km

Wetland Regional Ecosystem

- Marine
- Estuarine
- Riverine
- Lacustrine
- Palustrine

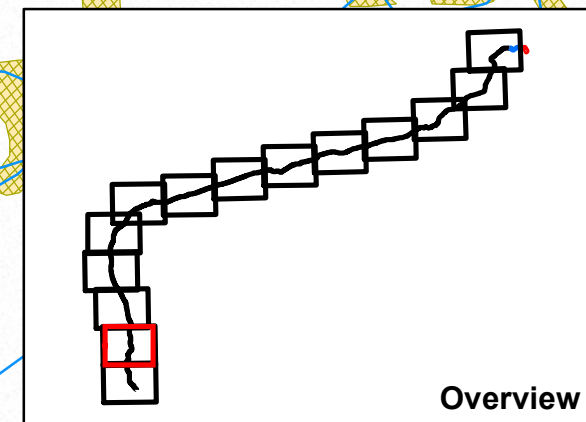
Water Body

- Marine
- Estuarine
- Lacustrine
- Riverine
- Palustrine

Areas that May Include Wetlands

- 51-80% wetland
- 1-50% wetland

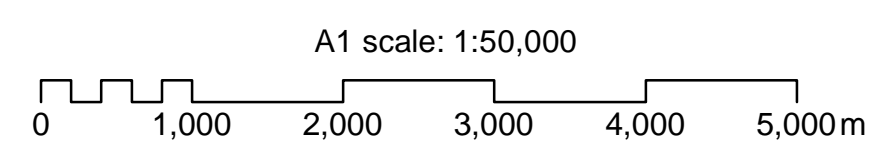
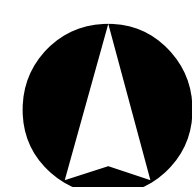
Watercourse



Overview

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Map by: BS



GLNG No: 3381-40-0430
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Wetland Systems
Figure 14.6 (Page 2 of 14)

Date: 11/04/2011

Version: b



Mainland GTP EM Plan

- Gas Transmission Pipeline (GTP)
 - Mainland GTP EM Plan
 - Marine Crossing GTP EM Plan
 - Curtis Island GTP EM Plan

- Kilometre Post Distance Marker
 - 50km
 - 10km

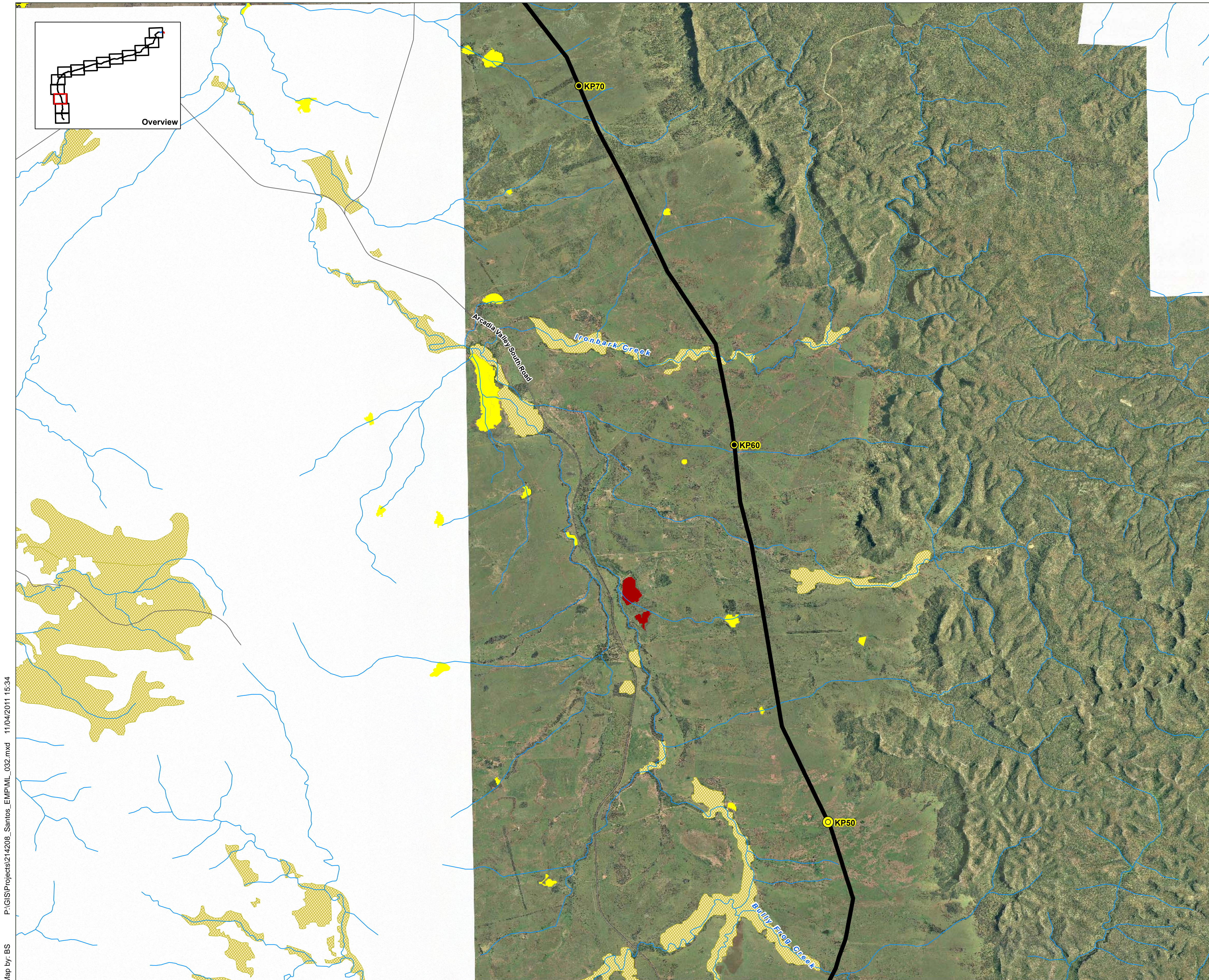
- Wetland Regional Ecosystem
 - Marine
 - Estuarine
 - Riverine
 - Lacustrine
 - Palustrine

- Water Body
 - Marine
 - Estuarine
 - Lacustrine
 - Riverine
 - Palustrine

- Areas that May Include Wetlands
 - 51-80% wetland
 - 1-50% wetland
- Watercourse

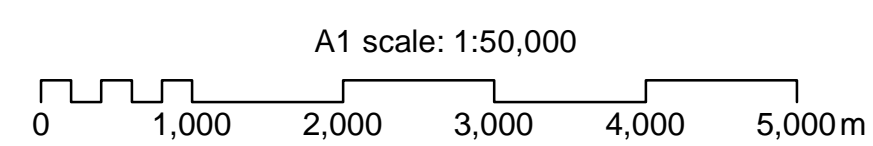
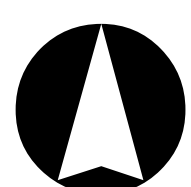
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Wetland Systems
Figure 14.6 (Page 3 of 14)



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Map by: BS



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GLNG No: 3381-40-0430
 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 50km
- 10km

Wetland Regional Ecosystem

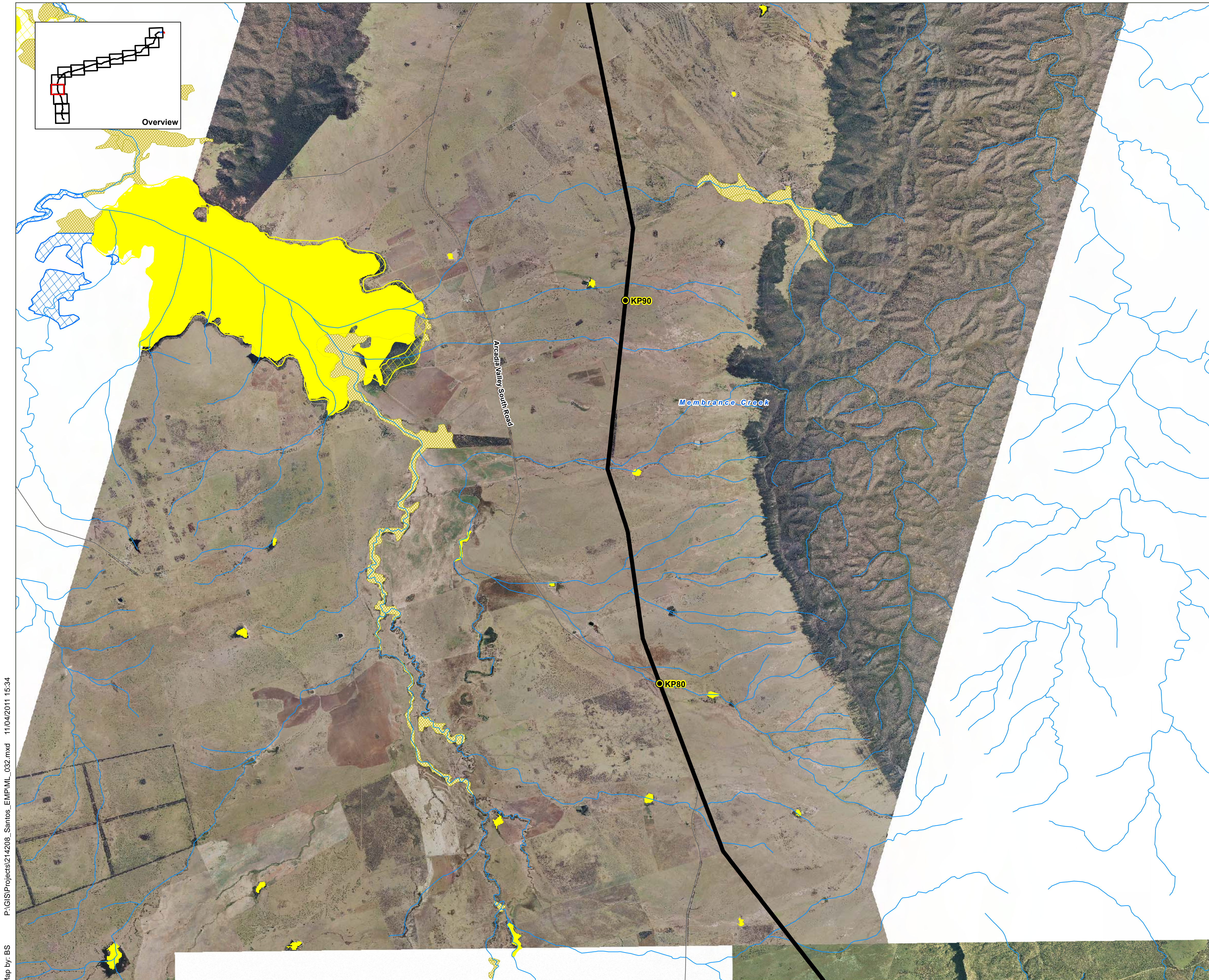
- Marine
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Water Body

- Marine
- Estuarine
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Areas that May Include Wetlands

- 51-80% wetland
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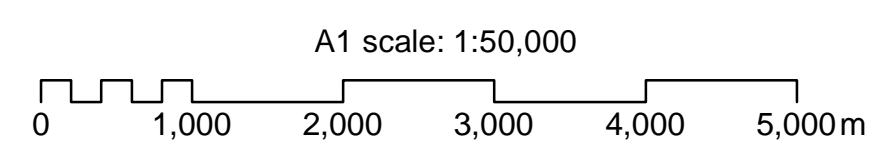
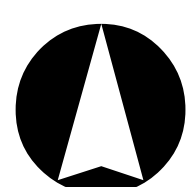


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Wetland Systems
Figure 14.6 (Page 4 of 14)

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Map by: BS



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Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
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Kilometre Post Distance Marker

- 50km
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Wetland Regional Ecosystem

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Water Body

- Marine
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Areas that May Include Wetlands

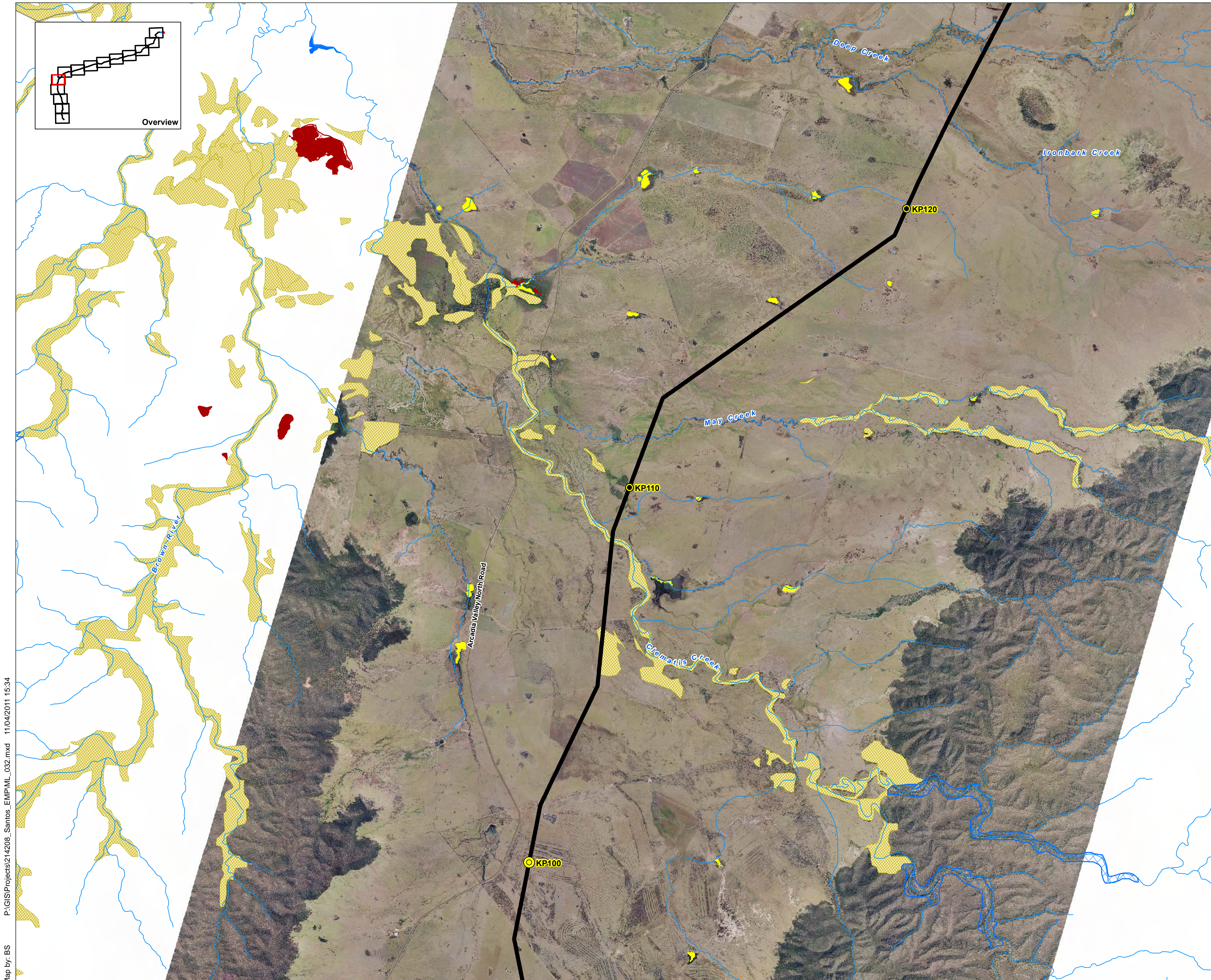
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Wetland Systems Figure 14.6 (Page 5 of 14)

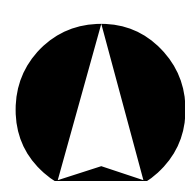
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Map by: BS



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GLNG No: 3381-40-0430
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Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
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Kilometre Post Distance Marker

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Wetland Regional Ecosystem

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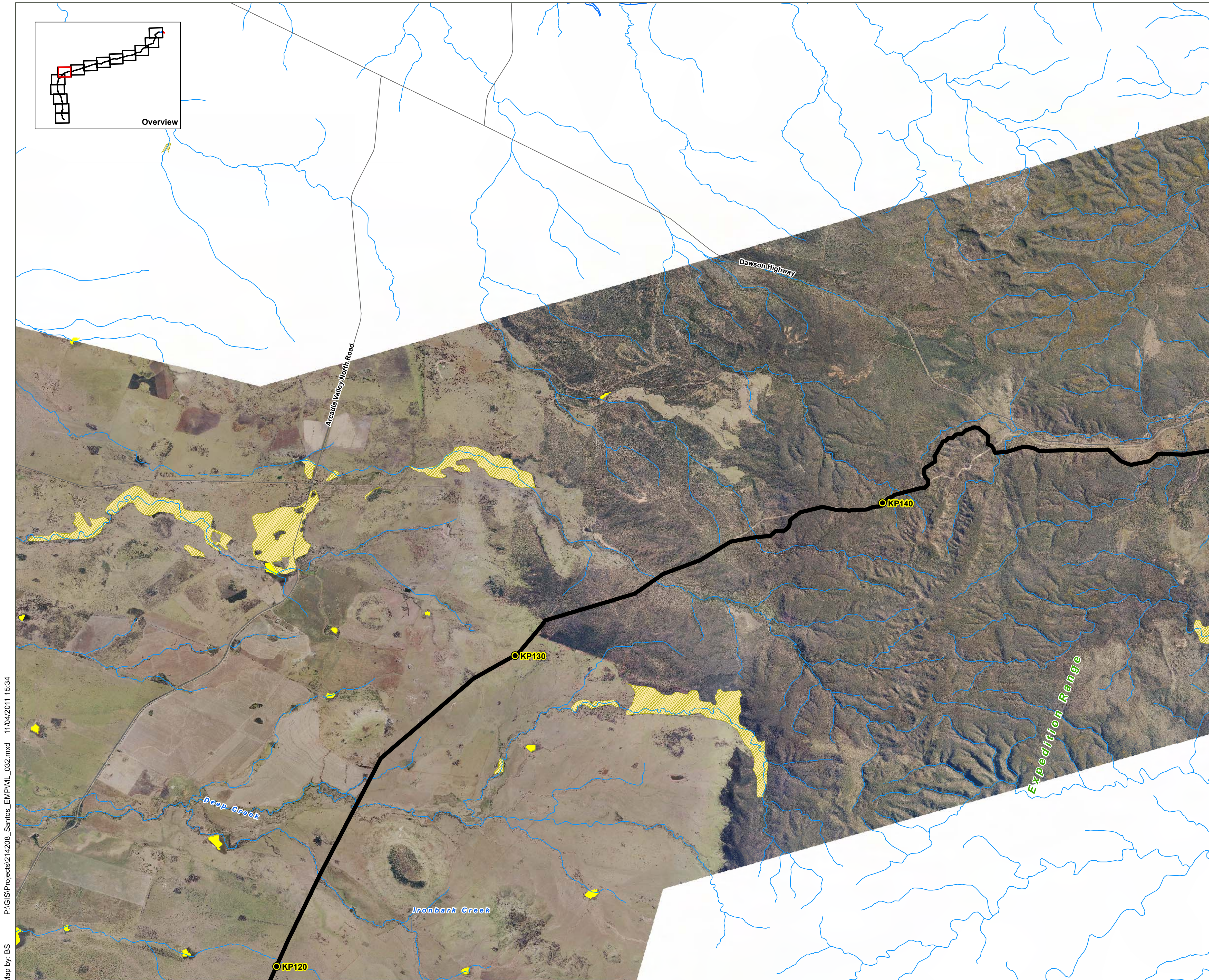
Water Body

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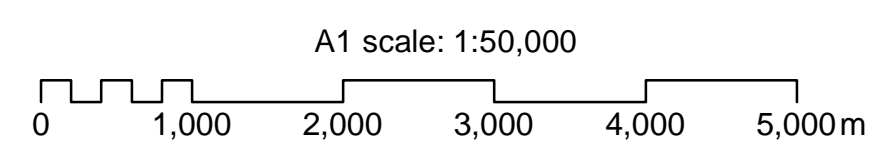
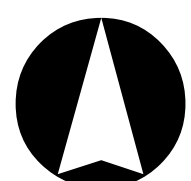
Wetland Systems
Figure 14.6 (Page 6 of 14)

Date: 11/04/2011

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 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

- Mainland GTP EM Plan
- Marine Crossing GTP EM Plan
- Curtis Island GTP EM Plan

Kilometre Post Distance Marker

- 50km
- 10km

Wetland Regional Ecosystem

- Marine
- Estuarine
- Riverine
- Lacustrine
- Palustrine

Water Body

- Marine
- Estuarine
- Lacustrine
- Riverine
- Palustrine

Areas that May Include Wetlands

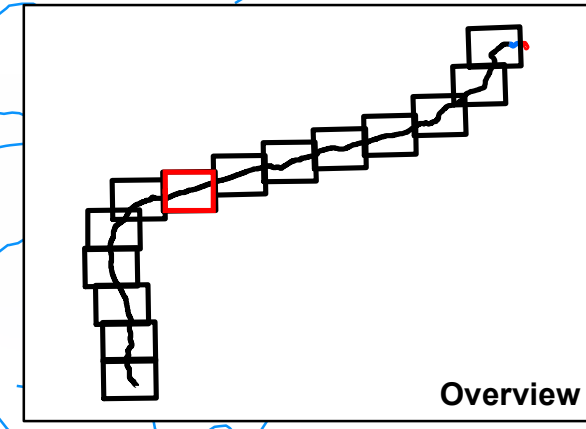
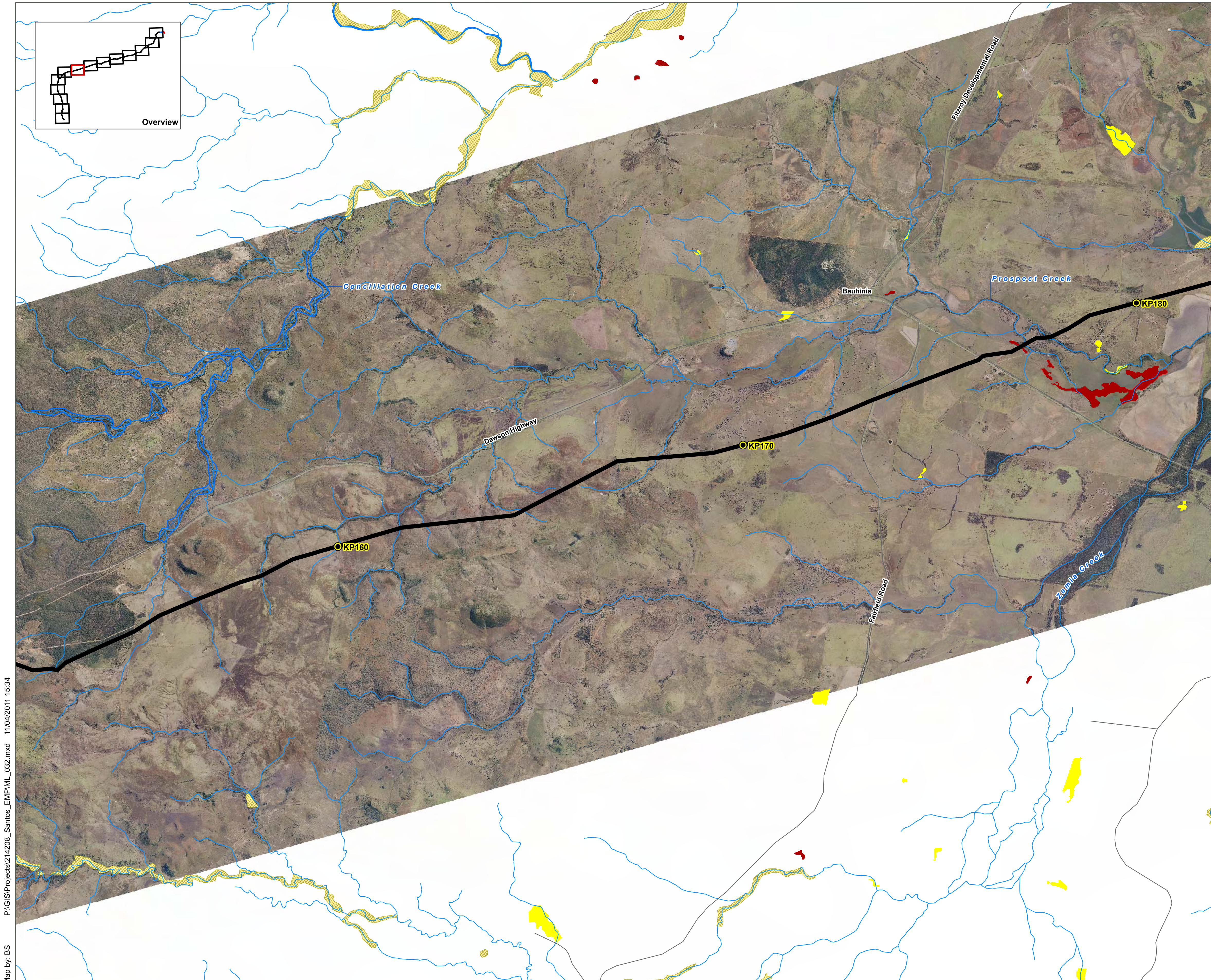
- 51-80% wetland
- 1-50% wetland
- Watercourse

Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Water Bodies and Wetland Regional Ecosystems:
 Queensland Wetland Data v1.2, Department of
 Environment and Resource Management, 2008.
 Watercourses: Department of Environment and
 Resource Management, 2009.

Wetland Systems
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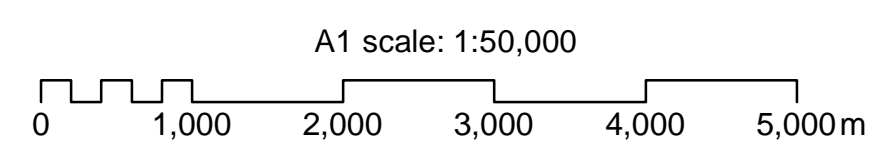
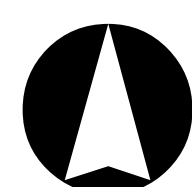
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Map by: BS



GLNG No: 3381-40-0430
 Coordinate system: GCS GDA 1994



Mainland GTP EM Plan

Gas Transmission Pipeline (GTP)

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Wetland Regional Ecosystem

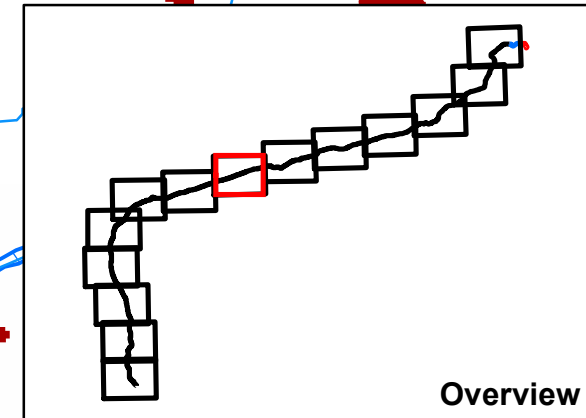
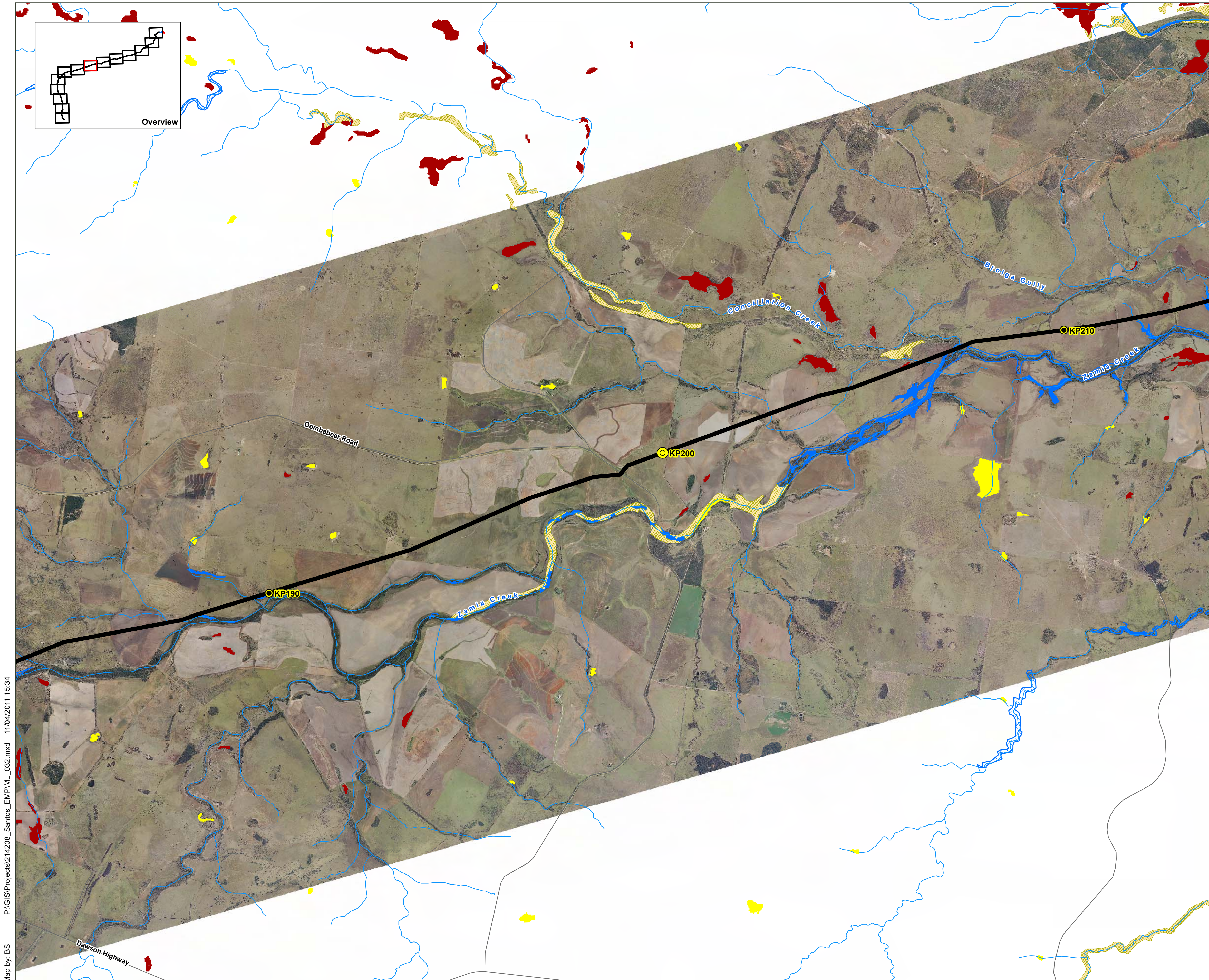
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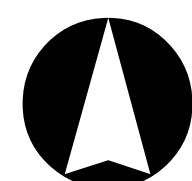
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Wetland Systems Figure 14.6 (Page 8 of 14)



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GLNG No: 3381-40-0430
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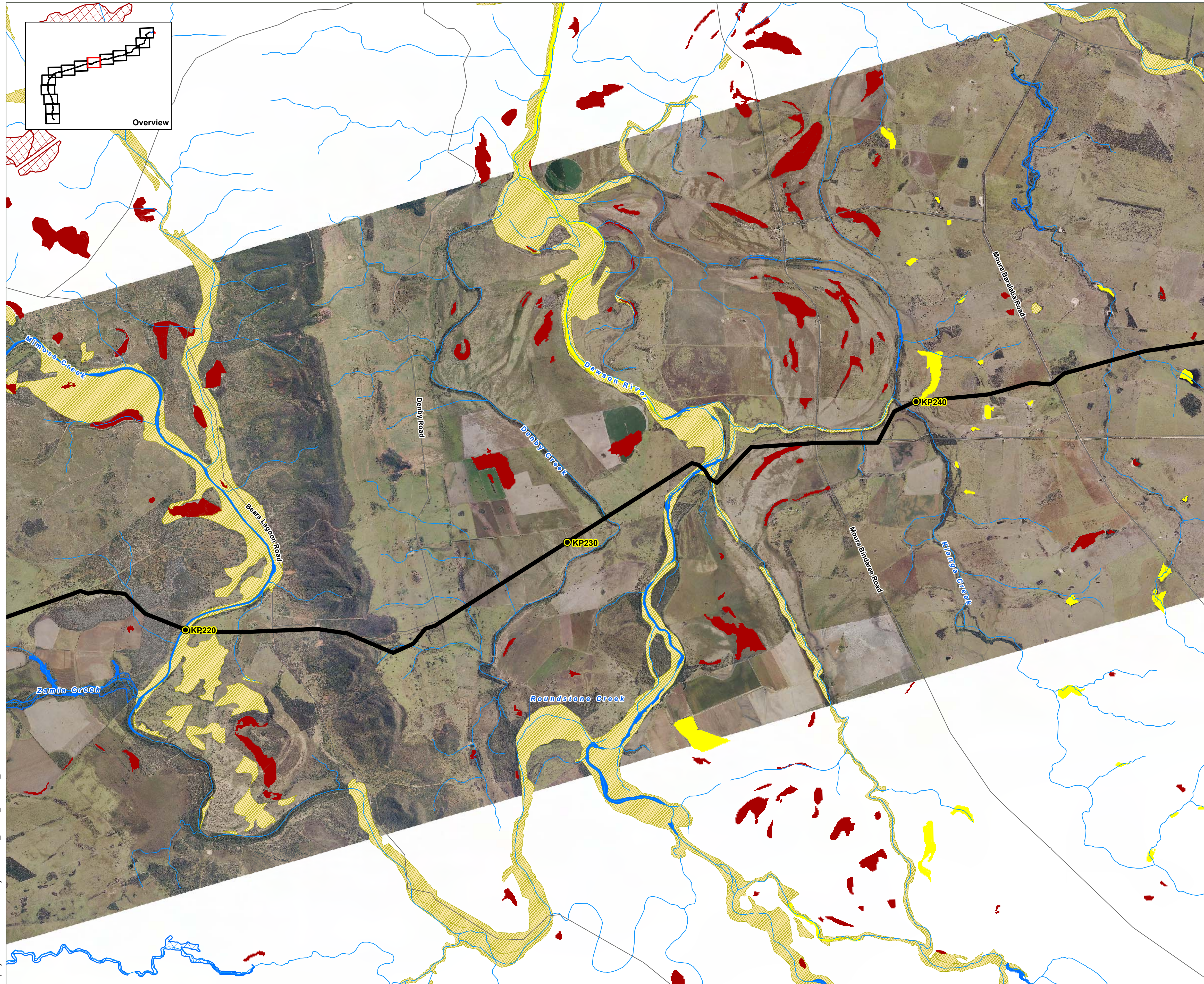
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Wetland Systems Figure 14.6 (Page 9 of 14)

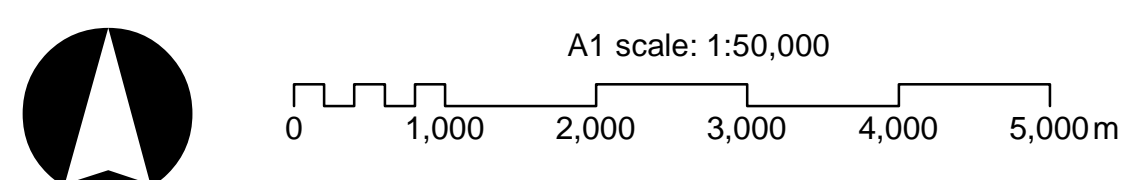
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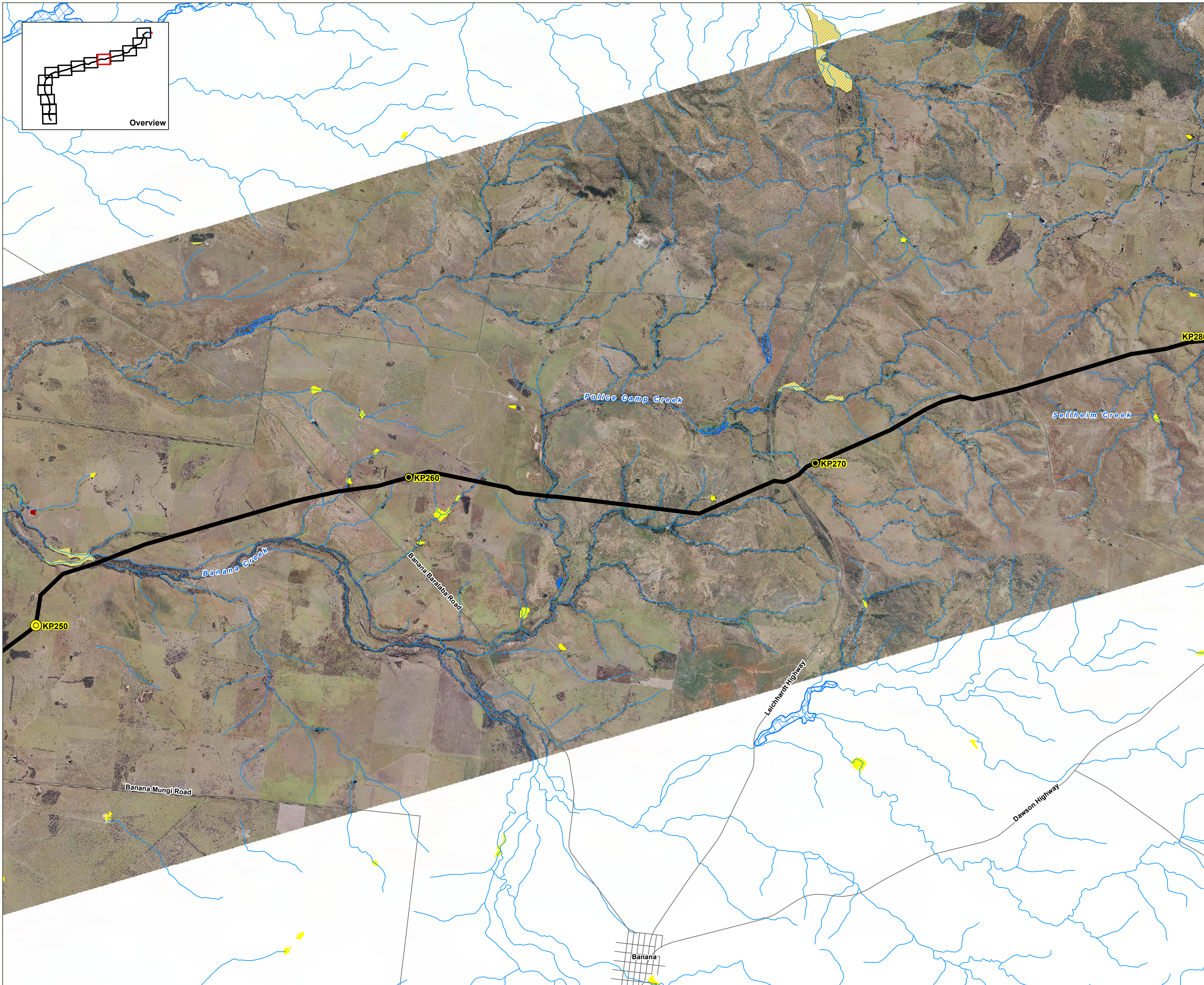
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Wetland Systems
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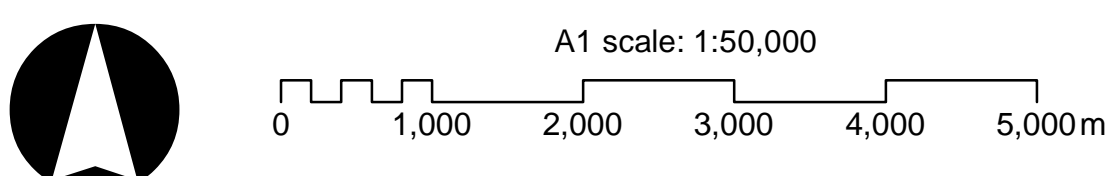
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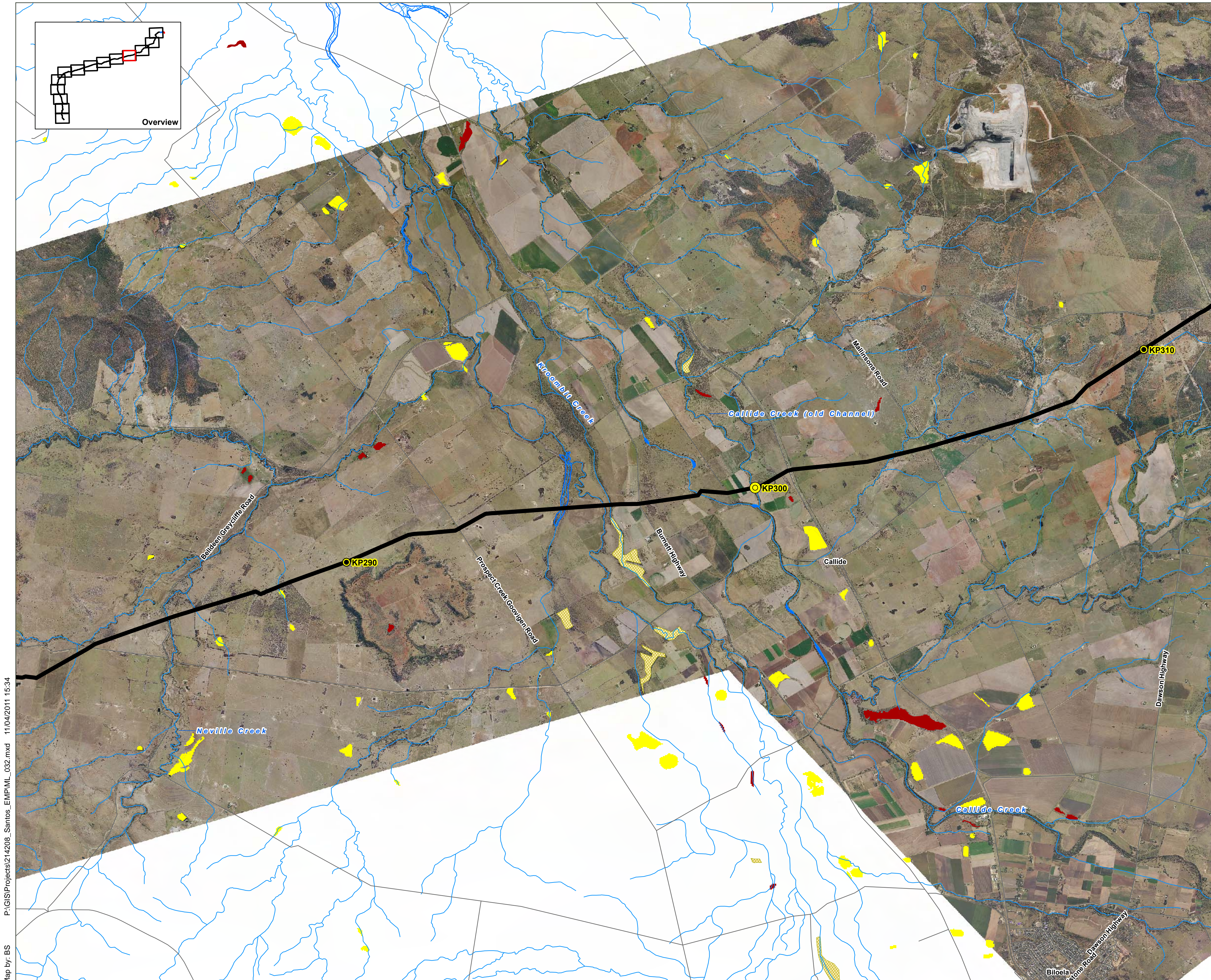
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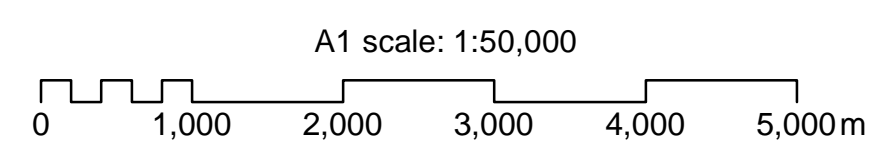
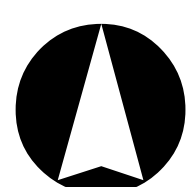


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Wetland Systems
Figure 14.6 (Page 11 of 14)

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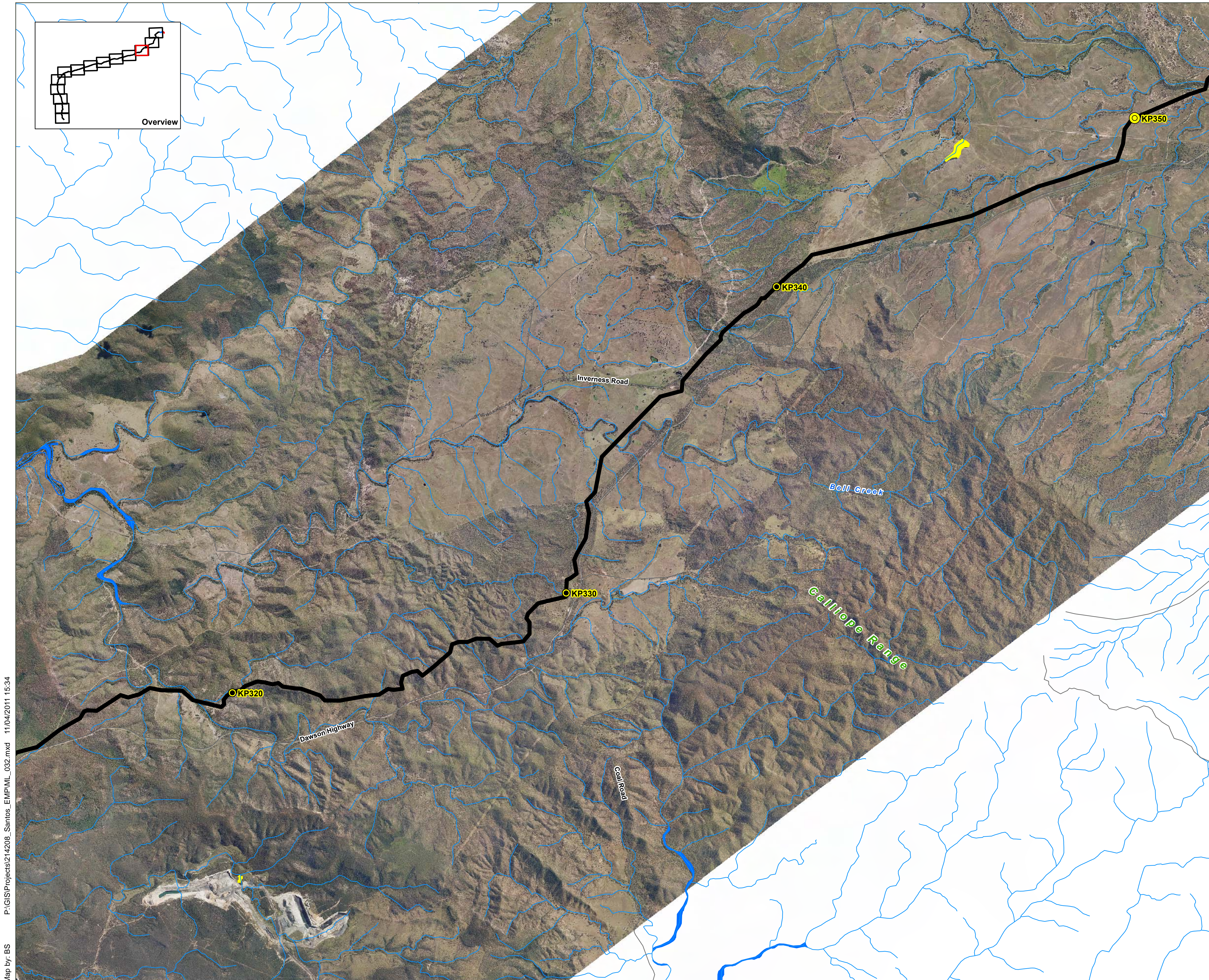
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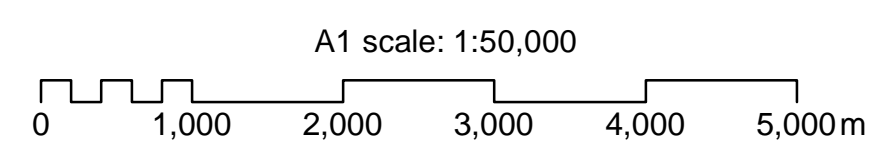
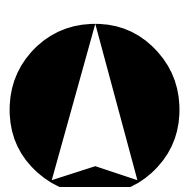


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Wetland Systems
Figure 14.6 (Page 12 of 14)

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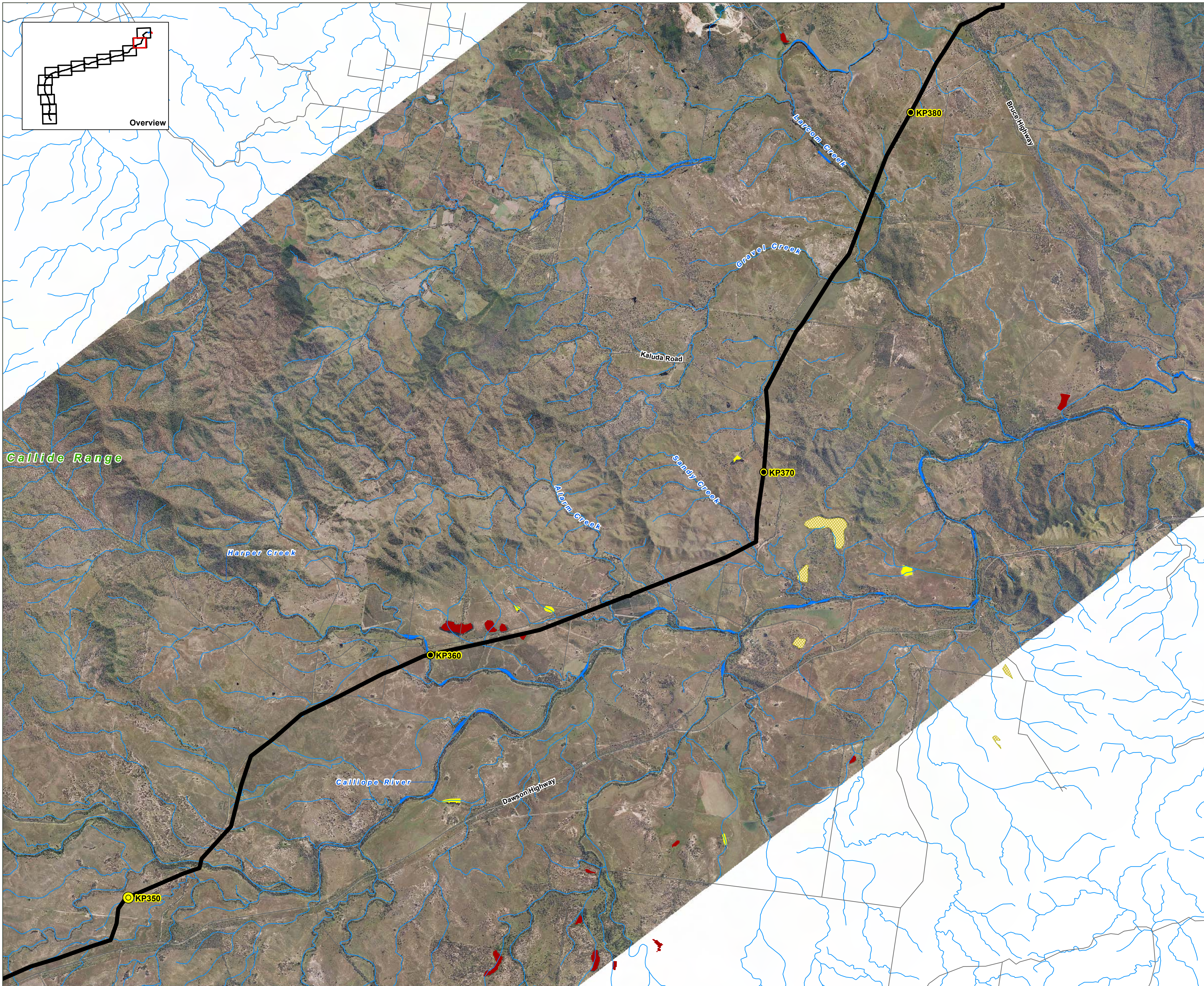
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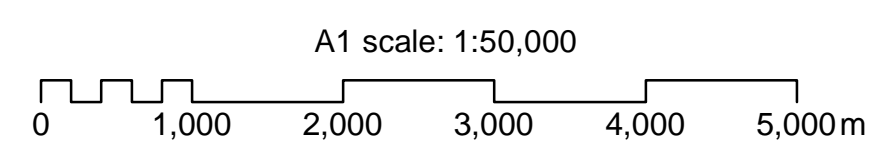
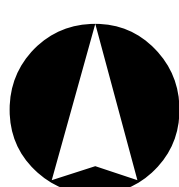
Wetland Systems
Figure 14.6 (Page 13 of 14)

Date: 11/04/2011

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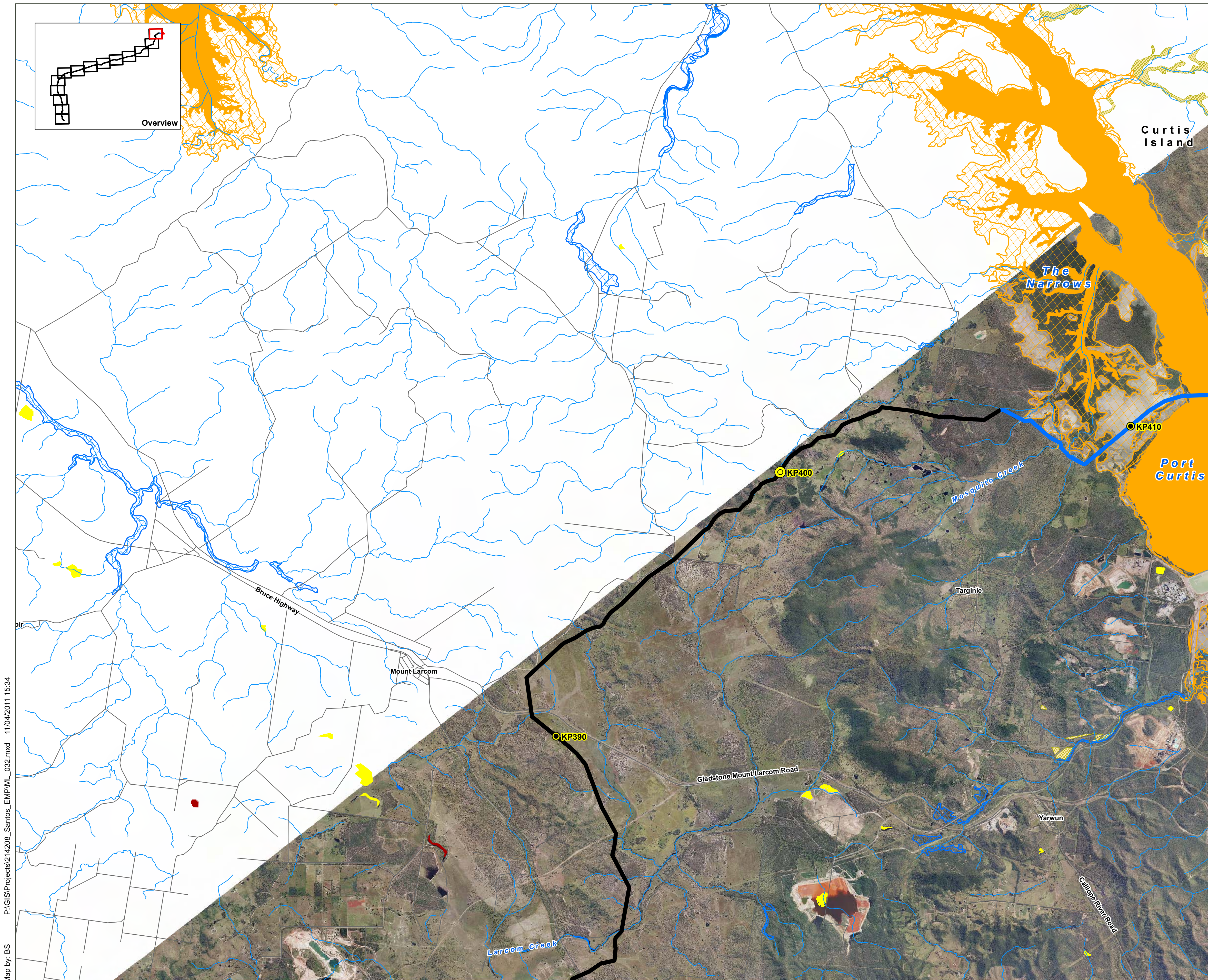
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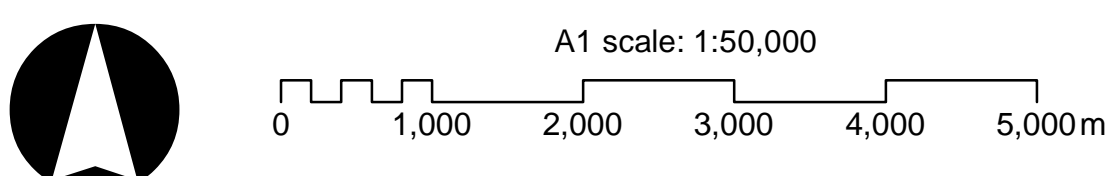
Areas that May Include Wetlands

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Wetland Systems
Figure 14.6 (Page 14 of 14)



unavoidable. This is particularly evident at riverine waterbodies and the other wetlands commonly associated with these types of waterbodies where crossings are necessary.

Hydrotest water

The integrity of the GTP will be verified via hydrostatic testing. This testing forms the key component of the commissioning phase for the Project, with details of the hydrostatic testing process having been described in Chapter 2.

14.2.2 Groundwater and aquifers

A high level assessment of large scale groundwater resources was undertaken along the approximate 420 km Mainland GTP RoW by URS (2009) as part of the EIS process.

Groundwater in the area is recognised as being utilised for domestic and stock watering purposes from shallow groundwater resources. Small scale irrigation using groundwater is also recognised to occur from the various shallow aquifers within the large study area.

The Mainland GTP RoW at the western end originates in the plateau country of the Great Dividing Range northeast of Injune. Soils associated with the plateau are predominantly sandy in texture, often very shallow or stony, with areas of sandstone rock outcrop. This plateau is a major recharge area for the sandstone aquifers within the Great Artesian Basin (GAB) sequence. Seasonal seepage and discharge from the confined aquifers can occur within the Great Dividing Range, depending on topography and hydrostatic pressures. This seepage may sustain groundwater dependent environments through discharge to creeks and water holes.

At the base of the escarpment, the proposed Mainland GTP RoW intersects alluvium-rich soils of the Upper Dawson River. This alluvium material contains shallow groundwater resources, used for agriculture, which are vulnerable to surface contamination due to high porosity and permeability in the sand and gravel material. These resources also have enhanced storage and recharge, which allows for moderate sustainable abstraction where the alluvium has large extent (spatial and depth) and interconnectivity.

The Mainland GTP RoW then proceeds north through the Arcadia Valley, which consists of gently sloping fans containing sandy soils and areas of medium to heavy clay. Broad alluvial plains of the Brown River and other streams within the Arcadia Valley are dominated by expansive uniform clay soils. The low permeability of the clay allows for the protection of deeper weathered and fractured rock aquifers in the sediments below.

East of the Expedition Range, the Mainland GTP RoW traverses mainly undulating plains and lowland areas, as well as the floodplains of Zamia Creek, Mimosa Creek, the Dawson River, Banana Creek and other streams. All of these contain large areas of mainly cracking and non-cracking clay soils and sandy soils. Groundwater potential is enhanced within these floodplains due to the increased recharge (both rainfall and creek flow), storage, and transmissivity. The groundwater in these floodplains is used for agriculture, both for stock watering and irrigation.

To the east of the Leichhardt Highway, the GTP traverses undulating and gently inclined plains underlain by tertiary sediments (which comprise sandstone, siltstone, claystone and conglomerate) and the floodplains of Kroombit Creek and Callide Creek. The soils within this section of the GTP comprise of cracking and non-cracking clays (in the lowlands) and sandy surface soils on the lower slopes of low rises. The tertiary sediments, in their pristine state, have low groundwater potential and require secondary processes, such as faulting and weathering, to enhance groundwater potential and are generally of limited use. Saturated sandy soils can provide storage and recharge to the underlying secondary aquifers.

The floodplains of the Calliope River and its major tributaries comprise of cracking clay soils and thin loamy surface soils. The thin clay-rich soils are expected to have limited permeability and transmissivity. The alluvial sediments have the potential to be used for stock watering and irrigation.

The final portion of the Mainland GTP, at the eastern end, crosses undulating plains and gently inclined slopes with sandy and loamy surface soils. The coastal areas comprise estuarine tidal marine

flats that have mainly deep, soft, saline clay, silt and muddy sand soils. The groundwater resources are limited due to poor groundwater quality (URS 2009).

14.3 Description of environmental values

14.3.1 Existing water quality

Surface water

Water quality assessment

An assessment was undertaken to characterise the current water quality of the watercourses and downstream receiving environment that has the potential to be impacted upon by works associated with construction of the Mainland GTP RoW. This included a review of water quality data from:

- DERM gauging stations located on four major watercourses in the area including Dawson River (Station No 130322A), Calliope River (Station No 132001A), Baffle Creek (Station No 134001B) and Mimosa Creek (Station No 130316A)
- Water quality monitoring activities undertaken by URS as part of development of the EIS at seven locations in close proximity to the proposed Mainland GTP RoW (these included Arcadia Creek, Basin Creek, Carnarvon Creek and Hutton Creek). Monitoring activities were undertaken on 3 February, 14 March and 6 May 2008

The results of the monitoring activities are summarised in Table 14.5. This information indicates that Total Nitrogen (TN) and Total Phosphorous (TP) exceed the water quality objectives of the Queensland Water Quality Guidelines (QWQG) 2006 in the majority of watercourses sampled. There is insufficient data regarding organic and inorganic nitrogen to determine if this is a result of organic matter being swept downstream, or if there are large inputs of inorganic nitrogen from industry or fertiliser runoff. These watercourses have been characterised as having a large annual sediment load (evident through on-site investigation), so it is reasonable to assume that a large proportion of the TN can be attributed to organic matter such as leaf litter.

Additionally, dissolved oxygen (DO) is low for a number of the watercourses. Two possible explanations are that the DO levels being recorded are being affected by high sediment loads and/or sampling was undertaken in incorrect conditions. Ideally, DO should only be recorded in watercourses that have a reasonable flow. However, water sampled in this investigation was often ponded (no flow) or subject to very little flow. In most cases, pH readings comply with water quality objectives.

Salinity is often an issue within the Fitzroy Basin and has been associated with land degradation, soil erosion, tree clearing and the overuse of groundwater supplies (FBA, 1996). However, measured Electrical Conductivity (EC) levels were within the water quality objectives at most sites, with elevated levels noted only in the Calliope River.

Several observations regarding seasonal variations were made. Generally, EC is higher in the dry season due to lower flows available to dilute the salts present. Dissolved oxygen (DO) is expected to be lower in the dry season, which is the case for some sites, but others show DO to be lower in the wet season. The Arcadia Creek sites tend to have a lower median pH in the wet season than in the dry, while all other sites analysed do not show obvious seasonal variation.



Table 14.5 Median water quality samples

Watercourse	EC (µg/L)	n*	DO (%sat)	n	pH	n	Turbidity (NTU)	N*	Total P (µg/L)	n	Total N (µg/L)	N*	Organic N (µg/L)	N*	NH4 (µg/L)	N*	TSS	n
																	(mg/L)	
NRW																		
1. Calliope River ²	1082	9	82	9	8.1	9	2	9	30	9	465	6	425	2	10	1	10	9
2. Dawson River ³	198	6	75	5	7.8	6	124	6	140	6	795	2	690	4	20	3	29.5	6
3. Mimosa Creek ⁴	285	1	86	1	6.9	1	1.1	1	30	1	-	-	590	1	20	1	10	1
1. Arcadia Creek @ Arcadia Valley Rd #1	198	1	65	1	7.4	1	91	1	180	1	1100	1	-	-	64	1	198	1
2. Arcadia Creek @ Arcadia Valley Rd #2	203	2	76	2	6.4	2	51	2	950	2	1000	1	-	-	39.5	2	203	2
3. Arcadia Creek @ Arcadia Valley Rd #3	199	2	91	1	5.6	1	23	1	550	1	2400	1	-	-	133	2	199	2
4. Arcadia Ck @ Sunny Holt	185	1	118	1	7.2	1	8	1	130	1	1200	1	-	-	10.5	1	185	1
5. Basin Creek @ Arcadia Valley Rd	169	2	59	2	6.8	2	423	2	700	2	2050	2	-	-	188	2	169	2
6. Carnarvon Creek @ Carnarvon Hwy	443	2	103	2	8.2	2	24	2	80	1	600	1	-	-	25	1	443	2
7. Hutton Creek @ Carnarvon Hwy	373	2	69	2	7.1	2	14	2	70	1	900	1	-	-	13	1	373	2
QWQG (2006)	340		85 - 110		6.5 – 8.5		50		50		500		420		20		na	

Table Notes * Number of samples

NH4 = Ammonia Nitrate TP = Total Phosphorus DO = Dissolved Oxygen Organic N = Organic Nitrogen
 TN = Total Nitrogen TSS = Total suspended solids EC = Electrical Conductivity

Years of data 1 1995-2005; 2. 1997-2003; 3. 1994-2001; 4. 1996

Wetlands and springs

Water quality assessment

There has been no water quality assessment undertaken in the vicinity of the WPAs or the wetland systems located within the RoW.

Document review

There are no studies on existing water quality of wetlands available in the Project area.

Groundwater and aquifers

Water quality assessment

A review of the DERM groundwater monitoring database has indicated that there are a number of groundwater monitoring bores located within the vicinity of the GTP. Those boreholes with available monitoring data within a 5 km radius of the GTP are illustrated in Figure 14.7. This figure shows the GTP separated into six geographical areas with a general description of the groundwater quality of each area outlined in Table 14.6 to Table 14.10. These tables provide a snapshot of groundwater quality along the RoW and include three parameters that briefly describe the water quality within these boreholes.

There is no groundwater data available for boreholes within Area 1.

Table 14.6 Groundwater monitoring data for Area 2

Registration number	Depth (m)	Conductivity (μScm^{-1})	pH	NO ₃ (μgL^{-1})
Guideline Value	-	340 ⁵	6.5 - 7.5 ⁶	700 ⁷
67474	115	600	8.1	0
67382	465	383	7.3	0
84049	95	760	8.2	500

The data in Table 14.6 indicates that the groundwater quality within Area 2 is particularly poor. Conductivity in all three bores exceeds the QWQG while two of the three bores exceed the QWQG for pH. However, it is noted that the groundwater is well within the Australia and New Zealand Environment Conservation Council (ANZECC) Guideline values for nitrate (NO₃).

Table 14.7 Groundwater monitoring data for Area 3

Registration number	Depth (m)	Conductivity (μScm^{-1})	pH	NO ₃ (μgL^{-1})
Guideline Value	-	760 ⁸	6.5 - 7.5	700
84912	27	8600	7.7	-
84913	40	4600	7.6	-
84915	33	2600	7.8	100
68210	7	2950	8.3	1000
68211	7	3050	8.2	0
84909	-	5900	8.0	3400

⁵ Guideline value adopted from QWQG Table G-1 (75th percentile for Fitzroy Central catchment)

⁶ Guideline adopted from QWQG Table 3.2.1.a (Upland streams)

⁷ Guideline adopted from ANZECC Guidelines Table 3.4.1 (95% of species protected in freshwater)

⁸ Guideline value adopted from QWQG Table G-1 (75th percentile for Calide-Upper Burnett catchment)

As with Area 2, the groundwater quality within Area 3 is poor. Conductivity and pH in all six bores exceed the QWQG. Conductivity is noted to be very high within Area 3. Levels of nitrate also exceed the ANZECC guidelines in two of the four boreholes monitored for nitrate.

Table 14.8 Groundwater monitoring data for Area 4

Registration number	Depth (m)	Conductivity($\mu\text{Sc m}^{-1}$)	pH	NO ₃ (μgL^{-1})
Guideline Value	-	760	6.5 -7.5	700
32680	-	2240	7.8	8000
38301	21	1250	7.7	-
31335	119	10190	7.2	15100
57789	-	4450	7.9	5300
17310	-	2530	7.5	-

Table 14.8 shows that groundwater quality is poor with very high conductivity levels. The conductivity of one borehole is approximately 13 times higher than the QWQG. pH values are exceeded in three of the five boreholes monitored. Nitrate levels are very high with one borehole measured at over 20 times higher than the ANZECC Guidelines.

Table 14.9 Groundwater monitoring data for Area 5

Registration number	Depth (m)	Conductivity($\mu\text{Sc m}^{-1}$)	pH	NO ₃ (μgL^{-1})
Guideline Value	-	970 ⁹	6.5 -7.5	700
111112	10.06	1222	8.1	1200
111111	11.8	1144	8	6300

Area 5 also has poor groundwater quality with exceedences in conductivity, pH and nitrate recorded at both boreholes.

Table 14.10 Groundwater monitoring data for Area 6

Registration number	Depth (m)	Conductivity (μScm^{-1})	pH	NO ₃ (μgL^{-1})
Guideline Value	-	970	6.5 - 8 ¹⁰	700
97678	30	3640	8	1100
97686	30	3640	8	6300
97443	22.8	2630	7.4	0
97444	20.7	4320	8	2000
97489	12.19	2880	7.3	1800
88337	38	1340	8.1	159000

The groundwater quality of Area 6 is also relatively poor. Conductivity is exceeded at all boreholes. The QWQG for pH are exceeded in only one of the six sites sampled. However nitrate is extremely high with one borehole monitored at approximately 227 times higher than the ANZECC Guideline value.

To conclude, Table 14.6 to Table 14.10 show that groundwater quality in the Mainland GTP RoW area is generally poor in the boreholes where data is available. Due to the high conductivities

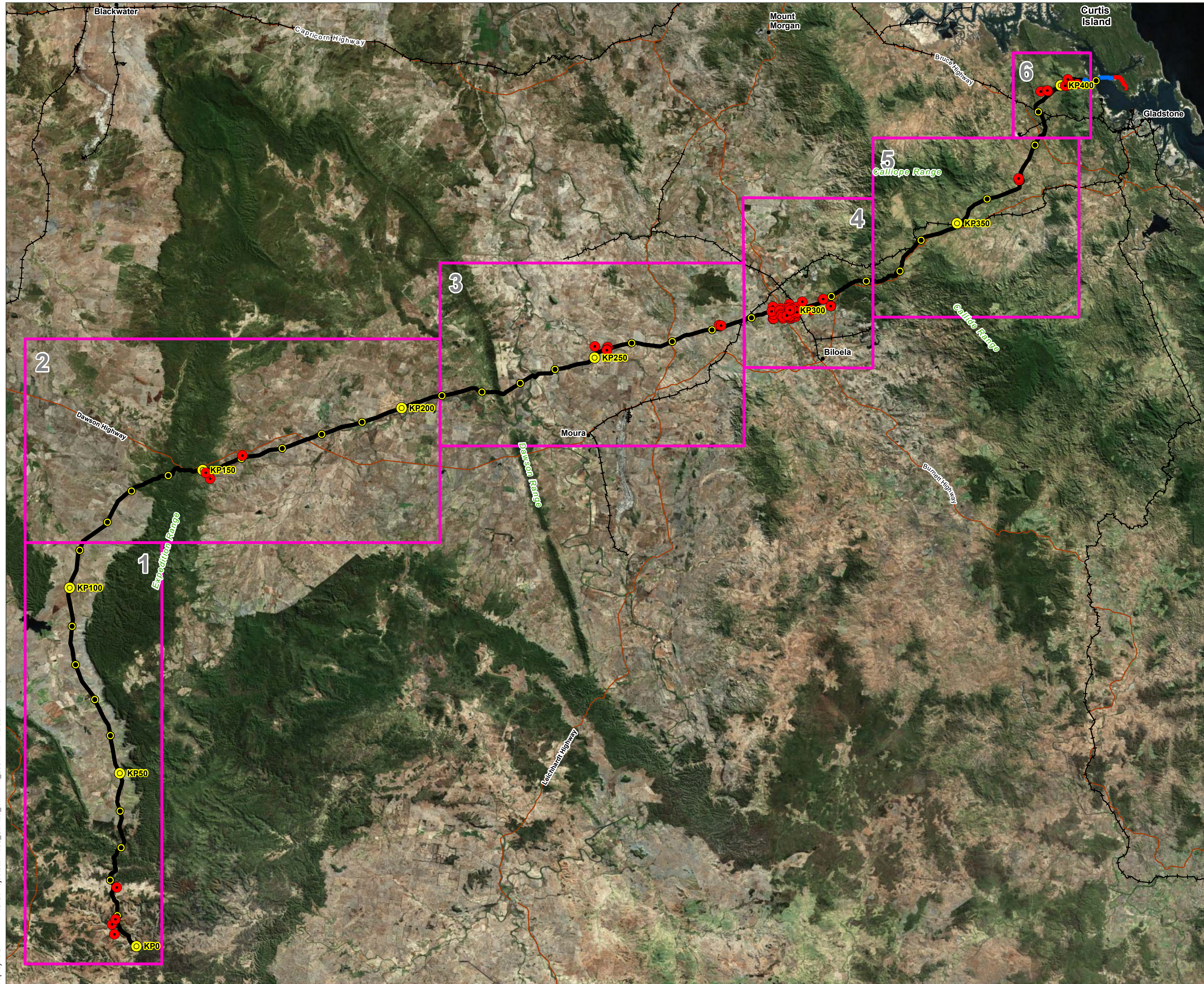
⁹ Guideline value adopted from QWQG Table G-1 (75th percentile for Central Coast South catchment)

¹⁰ Guideline adopted from QWQG Table 3.2.1.a (Lowland streams)



Mainland GTP EM Plan

- Gas Transmission Pipeline (GTP)
 - Mainland GTP EM Plan
 - Marine Crossing GTP EM Plan
 - Curtis Island GTP EM Plan
- Kilometre Post Distance Marker
 - 50km
 - 10km
- Groundwater Bore Areas
 - Groundwater Bores
- Rail
- Major Road



Source:
 Gas Transmission Pipeline (GTP): Santos, Jan 2011.
 Aerial: BING, 2011.
 Groundwater Bores: Department of Environment Resource and Management, 2009.

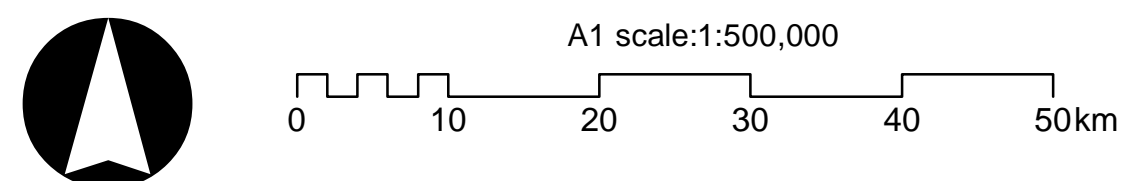
DRAFT

Groundwater Monitoring Bores Figure 14.7

Date: 28/06/2011

Version: c

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Map by: BS



GLNG No: 3381-40-0431
 Coordinate system: GCS_GDA_1994

observed, it is considered that the environmental values of the groundwater in the proposed RoW would be limited to some stock watering and agricultural irrigation.

14.4 Potential adverse or beneficial impacts on existing water related environmental values (construction and operation)

14.4.1 Surface water

Surface water may be impacted by works associated with construction and hydrotesting of the Mainland GTP RoW and other Project activities such as establishment of the temporary construction camps and temporary pipe storage sites. Details of the potential impacts on surface water bodies as a result of these construction activities are provided below.

Sediment exposure and mobilisation/erosion

Construction activities associated with the Mainland GTP RoW in the vicinity of drainage lines have the potential to mobilise sediment thereby potentially increasing the sediment load of nearby watercourses. Clearing and grading works in particular have the potential to cause increased sediment movement. Clearing and grading works will be required to be undertaken within the RoW, as well as the areas required for establishment of the temporary construction camps and temporary pipe storage sites. Clearing and grading works will need to take into account the location of any nearby drainage lines. Mitigation measures detailed in this EM Plan and in the ESCP (refer Appendix A) will need to be implemented to ensure that potential adverse impacts are minimised.

There is also the potential for the sediment within the cleared areas to become airborne during times of increased wind. This has the potential impact of causing a social nuisance and transferring sediment to nearby surface water bodies. Management measures identified in the EM Plan and ESCP will need to be implemented during times of increased wind to minimise the associated impacts.

As detailed in Chapter 3, the GTP will be required to traverse numerous drainage lines. Given the ephemeral nature of these drainage lines it is likely that these drainage lines will be crossed during times of no flow for the majority of the year. The potential impacts during times of no flow will be negligible. However in the case where water flow is present in the waterway during crossing works, there is the potential for increased sediment load and alteration of the flow characteristics of that waterway. Works will need to be undertaken in a manner that limits sediment movement and restores the drainage line to its pre construction condition. This will need to be in such a condition that the stability of the waterway bed and banks is not anymore susceptible to erosion than it was prior to the works commencing.

Chemical pollution

Potential sources of onsite chemical pollution during the construction phase of the Mainland GTP are predominantly associated with the storage/use of diesel and other petroleum-based fuels/lubricants used by excavation and construction machinery. Potential waste streams include oily wastewater; contaminated runoff from chemical storage areas; potentially contaminated drainage from fuel/oil storage areas; oil-filled transformer yard areas, and general washdown water. Contamination of the natural environment by such chemicals can lead to adverse effects on flora and fauna; decreased water and soil quality; toxicity; decreased visual amenity; and other negative implications.

Flooding

The possibility of out-of-bank/flash flood rainfall events during construction, present a risk to workers' health and safety, and may cause erosion and damage to erosion and sediment control infrastructure. There is also the possibility of litter and other construction waste being washed into watercourses during rain events, thereby impacting receiving water quality values.

Rehabilitating water crossings to a condition that varies to the pre development condition could also result in an alteration in water flow and thereby increase the possibility of flooding occurring.

Local water supply

Usage of large volumes of water during construction activities has the potential to diminish local water supply sources. The construction activities that will require large volumes of water include the hydrotesting process and water requirements for dust suppression. Water will also need to be sourced for operation of the temporary construction camps. This water will need to be of a potable standard and will be used for typical every day human use.

A lack of water supply has the potential to impact on the construction schedule and the environment. Dust suppression will be required to minimise mobilisation of sediment within cleared areas. Inadequate dust suppression can result in movement of sediment to nearby drainage lines thereby increasing sediment loads and has the potential to cause nuisance. Hydrotesting is also considered an essential component of the Project. Large volumes of local water of a suitable quality will be required for this process. Utilising large amounts of local water can result in a decrease in availability of water to other nearby users. To minimise impacts on local water supply it is proposed to maximise reuse of the hydrotest water along the length of the GTP.

14.4.2 Wetlands and springs

Similar to the impacts that may be experienced in surface water bodies, there is also the potential for wetlands and springs to become adversely impacted through sediment exposure and mobilisation, chemical pollution and lowering of water levels.

There is a higher potential for deposition of sediments in wetlands characterised by lower water flows. This may result in smothering of food resources and benthic habitats. It is also considered that wetlands have the potential to be more severely impacted by raised bed levels as a result of deposition of sediments coupled with low flow conditions.

Chemical pollution is of particular concern in wetlands and springs, particularly where there is little or no water flow to wash soluble pollutants out of the wetland or spring system.

It is considered that the impacts of sediment mobilisation and pollution may be more severe in habitats characterised by higher water quality such as spring-fed wetlands and streams where aquatic flora and fauna have become adapted to more pristine conditions.

A lowering of water levels in wetlands has the potential to partially or completely remove habitat for aquatic flora and fauna.

14.4.3 Groundwater

The DERM database states that groundwater in the vicinity of the GTP is mostly utilised for irrigation and domestic purposes and in some places for stock watering. Based on the shallow nature of the trenches and the overall deep groundwater (refer Table 14.6 to Table 14.10), it is envisaged that the impact on the hydraulic characteristics of shallow groundwater will be negligible except where the GTP directly intersects shallow groundwater. Further details regarding this issue are provided below.

Hydraulic characteristics

The Mainland GTP will be constructed primarily using the open trench method. Trenching involves the mechanical excavation of soil, regolith and shallow bedrock in order to facilitate the laying of the GTP. Blasting or the addition of formation or soil stabilisers (eg cement, dolomite in dispersive soils) may be utilised, depending on the competency of the underlying lithology.

There is the potential for groundwater recharge to increase along the trench and permeability, porosity and storage could be altered as a result of trenching. Alterations in shallow groundwater flow patterns, localised along the trench, are also a possibility. Altering existing hydrogeological conditions has the potential to adversely impact on the underwater groundwater levels and quality. This can have the follow on effect of changing the ecological values of groundwater dependant ecosystems such as wetlands and springs.

Blasting of rock outcrop can potentially alter fracture patterns and cause damage to nearby (± 200 m) boreholes. Construction of the Mainland GTP under watercourses will potentially require dewatering of the watercourse sediments, which will have a temporary impact on surrounding (alluvial) aquifers.

Chemical contamination

Potential sources of onsite chemical contamination during the construction of the Mainland GTP typically include diesel and other petroleum-based fuels and lubricants used by excavation and construction machinery. Potential waste streams include oily wastewater (from equipment wash water); contaminated runoff from chemical storage areas; potentially contaminated drainage from fuel/oil storage areas; oil-filled transformer yard areas, and general washdown water.

The primary storage areas for these chemicals and the resulting waste products will be within the temporary construction camps facilities. To ensure that these substances do not result in pollution of the underlying groundwater, their storage areas will be constructed and managed as per the Waste MP.

14.4.4 Hydrotest water

The integrity of the Mainland GTP will be verified via hydrostatic testing. This testing forms the key component of the commissioning phase for the Project with details of the hydrostatic testing process having been described in Chapter 2.

The water from hydrostatic testing will be reused along the length of GTP, so as to minimise the volumes of water that have to be sourced locally and then disposed of once hydrotesting has finished. Hydrotest water will be transferred from one test section to another by opening and closing valves. Additional chemicals (eg oxygen scavengers or biocides) are not proposed to be used, but this will be confirmed in the Hydrotest Water Management Plan (HWMP) that will be developed by the Contractor prior to the commencement of construction activities.

The preferred method to dispose of the hydrotest water is directly to land via vegetated areas and away from watercourses. All hydrotesting water released to land will be tested and comply with discharge limits and the conditions of the environmental authority. Discharge will be conducted in accordance with the HWMP.

14.4.5 Sewage treatment and disposal

Sewage generated from Project activities is proposed to be treated at the temporary construction camps in mobile package sewerage treatment plants. The treatment plants will be sized accordingly to the number of persons anticipated to reside at each of the 4 temporary construction camps. Potential contamination of the surrounding environment can come about from accidental release of untreated sewage or where the sewage is not treated to the relevant standards, thereby resulting in deterioration in local surface water and groundwater quality.

To ensure that potential impacts from sewage are minimised, it is proposed to dispose of treated effluent by irrigation. Sensitive areas will be avoided as will areas prone to soil erosion and soil structure damage. Discharge of treated effluent from wet weather storage to any waters will also be avoided.

Furthermore incidents resulting in a spillage of effluent to ground during construction will be managed in accordance with the Emergency Response Procedures (refer Chapter 3).

14.4.6 Summary of potential impacts

Construction

The construction of the Mainland GTP has the potential to impact on water related environmental values including increased erosion and sediment movement, decreased surface water and groundwater quality due to chemical pollutants, changes to surface water flow and groundwater hydraulic characteristics, and deterioration in local water supply. In particular, soil erosion and sediment presents a slightly higher risk due to the moderate to high erosion potential of the soils

within the Mainland GTP RoW. However, with the implementation of the ESCP (Appendix A) and the mitigation measures presented in Chapter 7, it is considered that the impacts associated with soil erosion and sediment are low and manageable.

The impacts to the surface water and groundwater quality as a result of chemical pollution are also considered to be low and manageable, as chemicals will be stored in accordance with the Waste MP (refer Appendix F), while hydrotest water will be treated to the approved water quality discharge limits and sewage will be treated to relevant standards. Hydrotest water will also be reused (where possible) during the hydrotesting process to minimise impacts on local water supply.

Construction and operation of the construction camps also has the potential to impact on surface water and groundwater quality. To ensure that such impacts are minimised, mitigation measures associated with clearing, erosion and sediment control and storage of hazardous materials as outlined in Table 14.11 will be implemented. To minimise adverse impacts on local water supplies, a water supply strategy will be developed and all necessary approvals will be sought from the relevant authorities.

Operation

Regular inspections will be carried out along the Mainland GTP RoW by vehicle and foot patrols to assess the condition of the GTP and associated infrastructure. Maintenance will typically be carried out by small maintenance crews in light vehicles on an annual basis, or as and when required.

It is considered that surface water quality impacts from operational activities are low and manageable due to the infrequent maintenance activities and vehicle movements during rainfall events. There are no anticipated groundwater impacts resulting from operational activities due to the shallow nature of the works.

Furthermore, all works associated with these operational activities will be undertaken in accordance with the Operational Management Plan (OMP) which will be developed prior to construction and implemented in all stages of the Project, including construction, operation and decommissioning. Typical OMP control measures have been outlined in Section 14.5.

14.5 Cumulative impacts

Cumulative impacts on surface water and groundwater are described below. This cumulative impact assessment is based on the impact scope, identification and scoring methodology described in Chapter 2 of this EM Plan. Cumulative impacts to surface water and groundwater are expected to be of minor significance as a result of the pipeline construction within the Mainland GTP. Cumulative impacts to water through surface water run off or ground water seepage may occur, however the application of appropriate environmental management plans will result in minor negative cumulative impacts.

14.5.1 Surface water (altered hydrology/altered hydrogeology)

Hydrology of watercourses may be affected by:

- Directly alteration as a result of topographical changes caused by construction works.
- Impeded of flow by the works structures in watercourses
- Diversion and dewatering during crossing construction

The only major river intersected by the CIC and GSDA corridors is the Calliope River. This is a permanent stream, which flows all year round. Environmental values for the Calliope River basin include:

- Protection of slightly to moderately disturbed aquatic habitat
- Suitability for primary contact recreation (eg swimming)
- Suitability for secondary recreation (eg boating)
- Suitability for visual (no contact) recreation
- Suitability for agricultural use
- Suitability for human consumers of aquatic food

- Suitability for industrial use (including manufacturing plants, power generation)
- Potential of cultural and spiritual values (EIS 2009)

Other tributaries that will be crossed by the pipeline routes include Larcom Creek and Bell Creek (located just outside the shared route).

A number of additional small or ephemeral streams are also crossed by the routes.

Creeks may be crossed using either open cut, boring or horizontal directional drilling (HDD). HDD will be considered where standard open cut methods are not feasible (EIS, 2009). GHD is currently planning a HDD crossing for the Calliope River.

Creek crossings may impact on the existing hydrology of the waterway through:

- Reduced flows as a result of dewatering during crossing construction
- Flow diversions
- Construction of barriers to flow, changing bank structures and disturbance to creek beds

Potential cumulative impacts may occur where construction takes place concurrently on the same watercourse or from a prolonged period of construction downstream of where the pipelines cross. These impacts may be intensified during the periods of construction of the creek crossings where dewatering will be required.

HDD may be used to limit impacts to stream hydrology in some instances. It is likely that, given the constant flow and ecological value of the Calliope River, HDD will be used (EIS 2009). Other waterways, such as Larcom Creek, Harper Creek and Bell Creek may be crossed using HDD.

The drainage from clearing the GTP RoWs may result in small changes to the hydrology and hydrogeology of watercourses. Assuming that all proponents will ensure that construction of the pipelines will occur during the dry season and given that the pipelines will be buried, significant alterations to watercourses will be minimal and short term. Any impacts will be readily managed through the EMPs.

There will be minor negative cumulative impacts on surface water (altered hydrology/altered hydrogeology).

14.5.2 Surface water (turbidity and sedimentation)

Increases in suspended sediment could derive from two potential sources:

- Erosion and runoff may lead to an increase in the levels of the suspended sediments quality to watercourses. This should be negligible if construction sedimentation is managed according to EMPs. However drainage from multiple sites across large areas exposed earth may lead to large erosion channels developing with subsequent discharges of suspended solids
- HDD carries a risk of loss of drilling fluid (bentonite) resulting in mud seepage into watercourses, potentially impacting on sediment load, deposition and contamination and potential impacts on fish at high concentrations

This should be minor if construction occurs in the dry season when flow is reduced and if sedimentation is managed according to EMPs.

All projects anticipate that there will be minimal impact to surface water quality. Therefore it is anticipated that there will be no significant cumulative impacts from multiple projects.

There will be minor negative cumulative impacts on surface water (turbidity and sedimentation).

Potential additional mitigation measures that will be considered during the preconstruction and construction phases of the Project are:

- Identify any opportunities to retain riparian vegetation along common stream banks through joint planning of GTP alignments and other supporting infrastructure

- Establish clearly defined and demarcated areas of riparian vegetation clearance for each project
- Sharing associated construction infrastructure near major water courses where possible
- Implement a common Erosion and Sediment Control Plan and drainage management, where pipeline routes are adjacent to each other and/or water crossings occur at the same time
- Coordinate rehabilitation of riparian vegetation to minimise the impacts of subsequent projects on rehabilitation for earlier projects

14.5.3 Surface water (other construction discharges)

Impacts on surface water quality may result from:

- Hydrotest water - Impacts from hydrotest water will largely depend on the nature of additives as some of these can be toxic to marine life. The LNG projects will not be discharging hydrotest water at the same time, and this will occur as isolated events. Provided that toxicity is not an issue, marine ecosystems should be able to recover from any minor impacts that do occur
- Spills of fuel oil and other contaminants may impact on water quality. Combined effects from concurrent projects may lead to higher concentrations of contaminants than from individual projects, which may in turn affect resilience of the marine ecosystem to assimilate effects

These impacts will be subject to the controls of the project specific EMPs and provided these are implemented should be minimal. However with increased activity there may be increased risks of spills and releases and potentially prolonged reductions in water quality.

There will be minor negative cumulative impacts on surface water (construction discharges).

Potential additional mitigation measures that will be considered during the preconstruction and construction phases of the Project are:

- Coordinated timing and location of hydro-test water discharge to avoid overlapping discharges land
- Avoid use of hydrotest water additives that may be toxic
- If chlorine is used, de-chlorinate hydrotest water before releasing
- Increase diligence in managing sources of contaminants

14.5.4 Ground water (impact on groundwater resources)

There are several registered groundwater bores located within the CIC and GSDA corridors. Significant aggregations occur around the Callide Range and where the NIC is intersected by the Bruce Highway. Groundwater is used for stock and domestic purposes.

Impacts on ground water may result from:

- Pollution from hydrotest water - assuming hydrotest water is not treated with additives such as biocides, corrosion inhibitor and oxygen scavengers no impact on ground water quality is anticipated
- Pollution from Fuel spills - Spills of fuel oil are not anticipated to significantly impact on groundwater. Assuming practice accords with the EMPs there is unlikely to be an impact
- Altered hydrogeology - The excavation and dewatering of the trenches may alter hydraulic gradients and change local groundwater movements in the area
- Local drawdown of aquifer from use in TAFs and hydrotesting water

Aquifers may be affected by large scale pumping required by multiple proponents for general use in temporary construction camps and for hydrotesting. This is likely to be intensified if work takes place simultaneously or over a short period of time before the aquifer can recharge. This could have a cumulative impact on individual boreholes.

There will be minor negative cumulative impacts on groundwater resources.

Potential additional mitigation measures that will be considered during the preconstruction and construction phases of the Project are:

- Discuss groundwater abstractions with other proponents to ensure that specific water resources are not exploited beyond capacity
- Increase diligence in managing sources of groundwater contamination
- Ensure trenching provides no permanent barrier to groundwater movements and does not provide for groundwater movement along the trench
- Monitor groundwater levels where trench dewatering from multiple projects is occurring in the same vicinity
- Monitor groundwater levels where trench dewatering from multiple projects is occurring in the same vicinity

14.6 Environmental protection commitments, objectives and control strategies – water (construction and operation)

Environmental protection commitments, objectives and control strategies proposed are discussed in Table 14.11. These control strategies were developed to ensure that the pipeline is designed and constructed in accordance with AS 2885.1 – 2007 Pipelines – Gas and Liquid Petroleum as well as other applicable standards and regulations, including the Australian Pipeline Industry Association (APIA 2009) *Code of Environmental Practice*.

Table 14.11 Environmental protection commitments, objectives and control strategies for water

Item	Detail
Environmental protection objective	<ul style="list-style-type: none"> • To minimise the potential impacts associated with erosion, prevent the release of contaminants that may adversely affect downstream surface water quality, and protect the quality of the existing groundwater resources
Specific objectives	<ul style="list-style-type: none"> • Prevention of direct or indirect release of contaminants to surface waters • Minimisation of incidences of accelerated erosion as a result of construction activities • Groundwater quality will not be impacted by development activities • Spill containment facilities constructed in accordance with AS 1940 (2004) and AS 3780 (1994) • Environmental impacts are within authorised limits

Item	Detail																										
Control strategies	<p>Pre construction phase</p> <ul style="list-style-type: none"> • A detailed assessment of aquatic values (including animal breeding places) along the pipeline route will be conducted. Site specific data will be included that accurately and comprehensively describes the environmental values and ecological condition at each aquatic site. The information will be used to determine the location of each watercourse or wetland crossing and site specific mitigation measures to protect the values identified • Detailed watercourse crossing plans will be prepared once the crossing methodology has been selected • Findings of engineering and geotechnical studies will be utilised in the design of crossings to ensure that the hydrological flow regimes are maintained • Open cut crossings of the Dawson River and any other known/identified habitat distribution for the Fitzroy River and White throated snapping turtles will be undertaken during no flow (if possible) and the dry season (Winter) and outside the known nesting time for both turtle species (Spring) • Crossings will be designed to provide for fish passage. Where practicable, bridge crossings will be designed to be single span (to minimise in-stream disturbance). Culverts will be avoided where possible and level crossings will be installed which allow the passage of heavy vehicles through the waterway but does not interfere with the flow of water. Where culverts can't be avoided, they will be designed so that they are: <ul style="list-style-type: none"> – As short and wide as possible, and allow the passage of anticipated flood volumes and debris – Deep enough to allow fish movement (a minimum depth of 0.5 m for the fish species present) – Installed without a 'drop off' at the culvert outlet or inlet (these impede fish migration) <p>Construction phase</p> <p>For hydrotesting, GLNG Operations will ensure that:</p> <ul style="list-style-type: none"> – Hydrostatic test water is not released to waters – Hydrostatic test water containing chemical additives is not released to land without written consent from the administering authority – Hydrostatic test water released to land does not exceed the water quality limits specified in Schedule C – Table 1 (see below) <p>Table 1- Water quality discharge limits</p> <table border="1"> <thead> <tr> <th>Parameter</th> <th>Maximum value</th> </tr> </thead> <tbody> <tr> <td>pH</td> <td>6.5-8.5 (Range)</td> </tr> <tr> <td>Arsenic (mg/L)</td> <td>2.0</td> </tr> <tr> <td>Cadmium (mg/L)</td> <td>0.05</td> </tr> <tr> <td>Chromium (mg/L)</td> <td>1</td> </tr> <tr> <td>Copper (mg/L)</td> <td>5</td> </tr> <tr> <td>Iron (mg/L)</td> <td>10</td> </tr> <tr> <td>Lead (mg/L)</td> <td>5</td> </tr> <tr> <td>Manganese</td> <td>10</td> </tr> <tr> <td>Zinc (mg/L)</td> <td>5</td> </tr> <tr> <td>Nitrogen (mg/L)</td> <td>35</td> </tr> <tr> <td>Phosphorus (mg/L)</td> <td>10</td> </tr> <tr> <td>Electrical Conductivity (uS/cm)</td> <td>2000</td> </tr> </tbody> </table>	Parameter	Maximum value	pH	6.5-8.5 (Range)	Arsenic (mg/L)	2.0	Cadmium (mg/L)	0.05	Chromium (mg/L)	1	Copper (mg/L)	5	Iron (mg/L)	10	Lead (mg/L)	5	Manganese	10	Zinc (mg/L)	5	Nitrogen (mg/L)	35	Phosphorus (mg/L)	10	Electrical Conductivity (uS/cm)	2000
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Item	Detail
	<ul style="list-style-type: none"> • The release of hydrostatic test water authorised as per EA conditions will be located at least 100 m from the nearest watercourse and carried out in a manner that ensures that: <ul style="list-style-type: none"> – Vegetation is not damaged – Soil erosion and soil structure damage is avoided – The quality of groundwater is not adversely impacted – Hydrotest water does not migrate outside the nominated land discharge areas. – Works in watercourses will only be undertaken where necessary for construction and no reasonable alternative location is feasible • Watercourse crossing points will be selected to, where practicable: <ul style="list-style-type: none"> – Minimise the extent of clearing of riparian vegetation – Avoid unstable and/or steep incised banks – Avoid bends in the channel and confluence with other channels – Avoid permanent and semi-permanent waterholes, and artesian springs • Horizontal directional drilling (HDD) will be used on selected watercourses, where practicable, taking into account environmental, engineering, logistical and geotechnical issues and advice from the drilling operator • Where HDD techniques are used, drilling mud will be treated as a hazardous substance and treated appropriately. Potential escape of drilling mud will be minimised by careful geotechnical investigation prior to drilling to ensure that geological fractures are avoided • Relevant approvals and permits will be obtained for crossings prior to construction • Crossings will, where practicable, be constructed in no-flow or low-flow conditions, and rehabilitation completed prior to the next wet season • The crossings will typically be at right angles to the direction of water flow to minimise scour potential • The disturbance corridor for the bed, bank and approaches to watercourses will be the narrowest practicable for safe construction • Additional work areas may be required at crossing locations for equipment operation and stockpiling of excavated material. These will be located outside the riparian area • No refuelling of plant, equipment or vehicles will occur within 50 m of any watercourse • The maintenance and cleaning of any vehicles, plant or equipment will not be carried out in areas from which contaminants can be released into any waters, roadside gutter or a stormwater drainage system • All construction vehicles shall carry spill clean-up kits, commensurate with the size and type of vehicle • Regional weather conditions and river flow levels will be monitored during construction to pre-empt changes in weather patterns and flow regimes to minimise impacts • Storage and loading/decanting areas for fuels and chemicals will be bunded and located outside the floodplain of the stream channels (ie approximately 50 m away from the top bank) • The staging areas will be limited to the narrowest area feasible and located outside the stream channel and riparian area • Large mature trees will be retained where practicable and trees will be trimmed in preference to removal to retain the root stock for stabilisation of the banks • Clearing of the slopes leading to the watercourses will be delayed until the construction of the crossing is imminent. Where this is not possible, other soil protection measures will be applied • All stockpiles (vegetation, watercourse bed material, watercourse bank material) will be stockpiled and stored separately in areas above the top of the bank and outside the riparian area where it will not be buried or damaged (ie free from traffic) • Stream bed material consisting of rocks, pebbles or coarse gravel overlying finer material will be stockpiled separately for replacement during restoration • Erosion sediment control measures will be located on the lower side of topsoil and bed and bank stockpiles and installed between the watercourse and the construction area to minimise sediment releases

Item	Detail
	<ul style="list-style-type: none"> • Temporary freshwater drainage measures such as diversion channels, pipes and bunding must be installed where required • Soils will be graded away from the watercourse, not towards it • Sediment and erosion control measures will be installed as required on watercourse approaches and banks to prevent any runoff from entering watercourses • Diversion banks will be used at the crest of, and on the slopes of, approaches to stream crossings to divert sheet flow away from backfilled trenches • Each diversion bank will have a stabilised outlet to safely disperse channelised flows • Watercourse crossings will be rapidly stabilised following construction • The bed and bank of watercourses will be restored as near as practical to the original profile and banks compacted to ensure stability • Access tracks across watercourses will be stable (ie rock lined) and level with the bed of the watercourse (not elevated) • Where an access track is required to be raised above the bed of the watercourse, appropriately sized pipes will be installed to ensure no interference with natural water flow • Topsoil will be respread over the area from where it was removed • Where required, sandbags, gabion or other scour protection measures will be installed, ensuring these are placed to conform as far as possible with existing natural contours. • Where required and agreed by landholders, access to the crossings will be restricted (i.e. by fencing or barriers) • Where required, terracing or surface water diversion berms will be placed along the top and intermediate points down the bank slope to encourage runoff to discharge on to stable (i.e. vegetated) areas or via sediment settling basins and not directly to the watercourse • Erosion sediment control measures will be installed on slopes to filter surface runoff water even if the watercourse is dry • Watercourses will be stabilised (eg rock gabion, jute matting) as required • All works in a watercourse bed will be completed within 24 hours unless prior approval is obtained from GLNG Operations • All works in watercourses, wetlands or springs will be for a maximum period of 10 days in order of the following preference: <ul style="list-style-type: none"> – Conducting work in times of no flow – Using all reasonable and practical measures to reduce impacts in times of flow – Horizontal directional drilling will be used for the construction of the pipeline across the Dawson River, unless the construction occurs in times of no flow or an alternative construction methodology is agreed with the administering authority in writing AW: this is most likely a particular EA condition. • All dewatering will be through erosion and sediment control devices • Activities or works resulting in significant disturbance to the bed or banks of a watercourse or wetland, or a spring must: <ul style="list-style-type: none"> – Only be undertaken where necessary for the construction and/or maintenance of roads, tracks and pipelines that are essential for carrying out the authorised petroleum activities and no reasonable alternative location is feasible AW: this description is consistent with the EA, which supports the approval of a Chapter 5A Level 1 petroleum activity, pursuant to the <i>Petroleum and Gas (Production and Safety) Act 2004</i> – Be no greater than the minimum area necessary for the purpose of the significant disturbance – Be designed and undertaken by a suitably qualified and experienced person taking into account the matters listed in Section 5. Planning Activities and Section 6 Impact Management during Activities of DERM's Guideline: Activities in a watercourse, lake or spring associated with mining operations, dated April 2008, or more recent editions as such become available – Upon cessation of the activities or works, commence rehabilitation immediately such that the final rehabilitation is to a condition that will ensure the ongoing physical integrity and the natural ecosystem values of the site. – Sufficient distance away from watercourses and mindful of potential to damage vegetation. There will be no release or dewatering of contaminants with potential to cause environmental harm to waters, land or groundwater

Item	Detail
	<ul style="list-style-type: none"> • All flammable and combustible liquids and dangerous goods will be stored, handled, used and transported in accordance with relevant Australian and Company standards • Hydrocarbon spillage from storage areas, diesel and chemical spills from construction equipment, and industrial waste spill will be contained, reported, and treated/remediated in accordance with appropriate legislative and regulatory agency requirements. Drainage will be reinstated • Wastewater from construction, cleaning and testing operations will be treated and managed in accordance with the relevant environmental authorities • Treated sewage effluent will generally be disposed of by irrigation. Sensitive areas will be avoided as will soil erosion and soil structure damage. There will be no discharge of treated effluent from wet weather storage to any waters • Management of hydrotest water will be in accordance with the environmental authority • A water supply strategy will be developed for the provision of water for the pipeline's construction. All necessary approvals will be sought from the relevant authorities • Contractors and suppliers shall source water for the workforce accommodation camps only from authorised sources of water • The Contractor will ensure that all potable water consumed on site, and at worker's accommodation complies with the Australian Drinking Water Guideline 2004 • Routine, regular and frequent visual monitoring will be undertaken while carrying out construction work and/or any maintenance of completed works in a watercourse, wetland or spring. If, due to the petroleum activities, water turbidity increases in the watercourse, wetland or spring outside contained areas, works will cease and the sediment control measures will be rectified to limit turbidity before activities recommence • Petroleum activities will not be carried out in River Improvement Trust Asset Areas without the approval of the relevant River Improvement Trust. Locations and details of River Improvement Trust Asset Areas can be obtained from the relevant River Improvement Trust. A list of the relevant River Improvement Trusts will be provided by DERM <p>Operational phase</p> <ul style="list-style-type: none"> • Typical mitigation and controls for the operational phase of the Project will be detailed in the Operational Management Plan, which will be developed post construction
<p>Performance indicators</p>	<ul style="list-style-type: none"> • No direct or indirect release of contaminants to surface waters • Minimisation of incidences of accelerated erosion as a result of construction activities • Groundwater quality is not impacted by development activities • Spill containment facilities are constructed in accordance with AS 1940 (2004) and AS 3780 (1994) • Environmental impacts are within authorised limits



GLNG

Gas Transmission Pipeline

EPBC Environmental Management Plan Mainland GTP – Chapter 15 Rehabilitation

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15. Rehabilitation

15.1 Rehabilitation objective

The key objective of landscape and rehabilitation works is to ensure that all statutory requirements pertaining to rehabilitation and landscaping are met and that the GTP RoW is re-established to a safe, non-polluting, stable and self-sustaining state.

15.2 Rehabilitation methodology

GLNG Operations has prepared a Landscape Rehabilitation Management Plan (LRMP) (refer Appendix G) which has been developed to provide details of rehabilitation management measures to be implemented during both construction and operational phases of the Mainland GTP works. The LRMP has been designed to act as a tool to guide GLNG Operations and the construction Contractor with information about the regulations and guidelines applicable to the Project.

The LRMP is a live document and will be updated as required during all phases of the Project. It is designed to:

- Minimise the area of overall disturbance
- Create a stable landscape
- Guide a program of comprehensive revegetation and rehabilitation for all disturbed areas
- Ensure revegetation and rehabilitation is undertaken in a timely manner
- Preserve downstream receiving environments
- Ensure compliance with relevant approval conditions specified by the Coordinator-General, DERM, Queensland Primary Industries and Fisheries (QPIF) and DSEWPC
- Ensure compliance with commitments under the EIS and SEIS

Table 15.1 below identifies the landscaping and rehabilitation works proposed that are relevant for the Mainland GTP RoW in order to meet the rehabilitation objective described above.

Table 15.1 Proposed mitigation and management measures for the Mainland GTP RoW

Item	Detail
Environmental protection objective	<ul style="list-style-type: none"> • To restore the RoW to be compatible with the surrounding conditions and pre-construction land use and compatible with the pipeline's operation
Control strategies	<p>Pre-construction phase</p> <ul style="list-style-type: none"> • A detailed rehabilitation plan will be developed prior to commencing the Project in order to account for the collection of seeds over the year prior to clear and grade. The plan will detail site specific rehabilitation methods, plans and monitoring programmes demonstrating compliance with GLNG Operations LRMP and EM Plan, all legal and regulatory conditions and soils management procedures. Seed collection will be planned to occur during the optimal times of the year for each significant species and grass to be collected • Prior to clearing activities, fixed photo points at appropriate locations will be established and recorded on a map. These photo points will assist to: <ul style="list-style-type: none"> - Determine the pre-clearing vegetation condition - Monitor and assess the rehabilitation success throughout the Route
	<p>Construction and Operational phase</p> <ul style="list-style-type: none"> • Progressive rehabilitation of disturbed areas will commence as soon as practicable following the completion of any construction or operational works associated with the authorised petroleum activities on the relevant petroleum authority • All land significantly disturbed by petroleum activities will be rehabilitated to: <ul style="list-style-type: none"> - A stable landform with a self-sustaining vegetation cover with same species and density of cover to that of the surrounding undisturbed areas, except over the area

Item	Detail
	<p>that must be maintained free of large flora species for pipeline integrity and access, and in cases where approval is sought in accordance with Condition E30 of Appendix 3, Part 4 of the CG Report. Large flora species are ones which may affect pipeline integrity or maintenance and functional activities;</p> <ul style="list-style-type: none"> - Ensure that all land is reinstated to the pre-disturbed land use and suitability class; - Ensure that the maintenance requirements for rehabilitated land are no greater than that required for the land prior to its disturbance by petroleum activities. <ul style="list-style-type: none"> • For areas of native vegetation, revegetation must use seed sourced from local provenance native species and where practical • Subsoil will be respread and compacted over the trench, with crown development, and used for the construction of contour banks on steep slopes and above banks at water crossings • Areas of the RoW will be deep ripped prior to topsoil spreading in consultation with the landholder • The RoW will be re-profiled to original or stable contours, re-establishing surface drainage lines and other land features • Topsoil application will only take place after subsoil respreading and compaction and will be evenly spread and left with a slightly rough surface • Driving vehicles on freshly topsoiled RoW will be prohibited • Subsoil displaced by the pipe, and not utilised in backfill, may be stockpiled in locations approved by the landholder for use during operations • Imported topsoil, of an appropriate quality and weed free, may be required for RoW repairs, and will only be used with landholder approval • Flagging used to identify clearing boundaries and sensitive features will be removed • Erosion and sediment control measures will be installed. Existing soil erosion measures will be reinstated to a condition at least equal to the pre-existing state • Where agreed to by the landholder, cleared native vegetation will be respread over the RoW to assist in the distribution of seed stock and provide shelter for fauna • Distribution of vegetation will be controlled to ensure that any erosion or subsidence that may occur will not be hidden from view during subsequent monitoring inspections • Native groundcover and shrubs will be encouraged to revegetate to minimise habitat barrier effects in significant habitat areas • Operation safety requirements must be considered when determining rehabilitation criteria. Trees with large root balls (such as Ficus sp.) pose a risk to the structural integrity of buried infrastructure. To ensure compliance with AS2885 (part 3, section 6.4.4), vegetation will be restricted to allow free passage along the pipeline route. Vegetation who roots may damage the anti-corrosion coating of the pipeline shall not be permitted in the vicinity if the pipeline. • In order to ensure operational safety, vegetation species used to rehabilitate the RoW will be limited to species less than 10 to 12 m in height. In areas where RE communities are to be rehabilitated, understorey species and mid-level species of pre-disturbance RE communities will be returned to the RoW. • Trees will be permitted to grow back on the RoW except in proximity to the pipeline and on the access track. • Environmental features such as rocks and dead timber will be replaced in the RoW where appropriate • A reseeded plan based on soil types, existing local vegetation characteristics and landholder preferences will be developed • Seeding will be utilised in areas where rapid restoration is required e.g. watercourse crossings and areas of high erosion potential • Where disturbed areas are to be re-planted or reseeded, preference will be given to local native species. However, non-native and non-invasive grass seed stock may be used in where approved by the landholders to stabilise temporary banks/stockpiles and will be removed and re-established as native vegetation post construction. • Rehabilitation must encourage the maximum re-establishment of native vegetation including the shrubby understorey and ground cover • Where applicable, any imported topsoil that is required for use in rehabilitation works will be of a similar quality to the topsoil it is replacing and will be weed and pest free
	<ul style="list-style-type: none"> • Locally sourced species and intensive planting for rehabilitation will be used in riparian

Item	Detail
	<p>areas</p> <ul style="list-style-type: none"> • Rehabilitation works will incorporate the use of habitat/fodder trees for koalas and other key significant fauna species in the species selection • On completion of construction on land identified as GQAL, all temporary access tracks will be removed, land management and erosion control measures will be implemented and disturbed areas will be lightly ripped, topsoil replaced and surfaces returned to preconstruction land use condition • Trees and shrubs will be allowed to regenerate naturally on cleared areas not required to be kept tree free for pipeline protection and maintenance • In areas proposed for revegetation, seed will be evenly dispersed over the entire disturbed area • Fertilisers and soil supplements will be used only as necessary with the agreement of landholders and authorities • Permanent pipeline warning signs will be erected along the easement • All waste materials and equipment will be removed from the RoW once backfilling and tie-ins are completed • Temporary access roads will be closed and rehabilitated to pre-disturbed condition, compatible with the surrounding land use or as agreed with the landholder • Where access routes are to be retained, but are not public access, the entry will be disguised (e.g. by dog-legging, brush spreading) • Disused erosion sediment control measures will be removed • Fences or other barriers will be installed where appropriate and where approved by the landholder to minimise unauthorised access • Weather permitting, rehabilitation of areas containing Least Concern (including Type A) plants will begin within 3 months of completion of pipeline construction. Revegetation will be consistent with the plant density, floristic composition and distribution of the surrounding regional ecosystem types and within the province of the vegetation being cleared • For clearing impacts that result in permanent loss of least concern native plants (cannot be re-established within three (3) years of clearing or floristic modification), the Contractor must provide GLNG Operations with a written detailed report of permanent vegetation loss, including the area, species affected and mapping of affected areas, within 12 months of completion of the pipeline construction • Pasture areas will be resown with seed mix agreed by GLNG Operations. • Maintenance of seeded areas shall continue until: <ul style="list-style-type: none"> – At least an equivalent amount of ground cover has been achieved as in adjacent land over 95% of disturbed areas; – Weed content is equivalent to or better than adjacent areas undisturbed by construction. • Revegetation of cropland will generally not be required as landholder will have received compensation including resowing of disturbed areas. • Areas vegetated with trees or shrubs on agricultural land will be revegetated with similar vegetation mix or with pasture as agreed with landowner. • Roadside areas will be replanted in accordance with Department of Transport and Main Roads/Local Authority requirements and to the pre-construction standard or better. • Bushland areas will be revegetated with like species from commercially available seed mixes or seeds collected in adjacent areas. Seed collection will be undertaken as per the Seed Collection Plan and in accordance with seed collection guideline document: <i>Model Code of Practice, Florabank Guideline 6: Native Seed Collection Methods</i>, Available at http://www.florabank.org.au/ 5 Feb 2012' • Highly sensitive areas and watercourse crossings will require rehabilitation with local provenance seed stock. • For pasture areas rehabilitation will be undertaken so as: <ul style="list-style-type: none"> – An equivalent amount of ground cover to adjacent land has been achieved over 95% of disturbed areas; and – Weed content is less than adjacent areas undisturbed by construction.
	<ul style="list-style-type: none"> • For native vegetation and stream areas rehabilitation will be undertaken so as: <ul style="list-style-type: none"> – Trees and shrubs are viable without further maintenance.

Item	Detail
	<ul style="list-style-type: none"> - Weed content is less than adjacent areas undisturbed by construction. • Maintenance of rehabilitated areas will take place to ensure and demonstrate: <ul style="list-style-type: none"> - Stability of landforms; - Erosion control measures remain effective; - Stormwater runoff and seepage from rehabilitated areas does not negatively affect the environmental values of any waters; - Plants show healthy growth and recruitment is occurring; - Declared pest plants are controlled on rehabilitated areas to a level consistent with the surrounding property and prevented from spreading to unaffected areas through authorised petroleum activities • Rehabilitation can be considered successful when the site can be managed for its designated land-use (either similar to that of surrounding undisturbed areas or as otherwise agreed in a written document with the landowner/holder and administering authority) without any greater management input than for other land in the area being used for a similar purpose and there is evidence that the rehabilitation has been successful for at least 3 years • As noted above, large species (i.e. greater than 10 m) will be restricted from the RoW in order to protect the structural integrity of the buried pipeline.

15.3 Proposed decommissioning works

The overall rehabilitation objective at decommissioning is to rehabilitate land to a level consistent with the pre-use activity.

As previously discussed in Chapter 2, decommissioning of the pipeline will be undertaken using the “in place” abandonment method, as this method has the least adverse environmental impact and will be undertaken in accordance with policies at the time of decommissioning and in line with best practice at the time. The various “in place” abandonment options that will be considered are:

- Abandon by air/inert gas displacement
- Abandon by water fill displacement
- Abandon by right-of-way and above ground facilities

As the “in-place” abandonment options identified above result in minimal intrusive works during the decommissioning of below ground infrastructure, it is not envisaged that there will be large amounts of rehabilitation works required to be undertaken.

Any removal of above ground infrastructure will be subject to the rehabilitation works, indicators and completion criteria proposed for the post-construction phase. Details regarding these are described throughout the remainder of this chapter.

During the decommissioning phase of the pipeline, vegetation with large root balls (i.e. trees greater than 10 m) will be re-established within the RoW. This type of vegetation will be restricted during the operational phase to protect the structural integrity of the pipeline. Revegetation of these species may be undertaken through passive (i.e. allow for the natural encroachment of the species) or active (i.e. planting/seeding) methods depending on best practice at the time of rehabilitation.

15.4 Rehabilitation completion criteria

Due to the variability in complexity of vegetation communities across the Mainland GTP RoW, it is difficult to set criteria for determining when a site has been completely rehabilitated. In addition, the completion criteria will be dependent on the land use prior to clearing, pre-existing health and integrity of the landscape and landholder requirements.

However, the aim is to rehabilitate impacted environs to their pre-existing condition (as a minimum). This is a particular prerequisite for all significant ecological communities, protected areas and other sensitive areas identified within the Mainland GTP RoW.

In determining whether the completion criterion is met the following factors will be used:

- The similarity between the rehabilitated landforms and the natural landforms in adjacent areas
- The stability of the landform and its resistance to erosion
- Whether appropriate drainage patterns have been developed, either naturally or through shaping activities during the rehabilitation programme
- The degree to which the surface conditions are conducive to plant establishment
- Whether the site conditions and existing habitat components provide resources, including for fauna movement, foraging habitat and/or shelter
- Compliance with the relevant standards
- Public safety issues (eg signage, fencing etc)

Table 15.2 below provides a high level overview of the rehabilitation goals, objectives, indicators and completion criteria proposed for the Mainland GTP RoW. These will be further expanded upon by the Contractor in the Contractor's LRMP and prior to the commencement of construction activities.

Table 15.2 Rehabilitation goals, objectives, indicators and completion criteria

Rehabilitation goal	Rehabilitation objective	Indicators	Completion criteria
Safe	Site safe for humans	Landform similar to adjacent natural landforms	Land has been rehabilitated to its predevelopment stability condition
Non-polluting	No adverse impact to land and water quality values	All erosion and sediment control features implemented and functional Surface water monitoring	Erosion controlled and limited to that associated with natural processes Water quality monitoring meets release limits
Stable	Minimise erosion and sediment movement	Landform similar to adjacent natural landforms Vegetation cover	No subsidence or areas of major erosion After 2 years the average crown covers is approximately 50%
Self-sustaining	Construction areas are rehabilitated to a self-sustaining level	Surface conditions are conducive to plant establishment	At the end of year 2: A minimum of 80% of planted stock have survived Fast growing shrubs have achieved an average height of 1.0 m Slow to medium growing shrubs have achieved an average height of 0.7 m A minimum of 70% of mulched planting areas are free of weeds

15.5 Inspections and reporting

The following inspection schedules are proposed for the Mainland GTP RoW:

- Once rehabilitation has commenced, regular inspections will be carried out to monitor watering requirements within rehabilitation areas for a period of three months. Weekly inspections will then commence for a further period of six months.
- Where applicable, weekly inspections will also be conducted to monitor and record the success of planting regimes for a period of six months after plantings have commenced.

- Bi-monthly photographs will be taken from monitoring points to determine the success or otherwise of the landscaping and rehabilitation works. These will be included in the monthly environmental report. This will be carried out for a minimum of three years after plantings have commenced

A monitoring and evaluation report will be prepared and will include details on species survival, natural recruitment, percentage coverage of the rehabilitation area and percentage and species of weeds in the rehabilitated areas. In addition the following will also be recorded:

- Planning and impact assessment details;
- Activity site location and site access details;
- Commencement and completion dates;
- The area of native vegetation removed, and the amounts of material excavated and fill placed;
- The disposal location/s and quantity of spoil material removed;
- The disposal location/s and quantity of native vegetation removed;
- Impact management and rehabilitation details;
- Before, during and post activity photographs of the site;
- Any incidents of unanticipated failure of management methods and subsequent remedial action;
- Any notable fauna activity will also be recorded.

Where there is a permanent loss of native vegetation (cannot re-establish within three years), a written detailed report of permanent vegetation loss, including the area, individuals species affects and mapping of affected areas will be provided to DERM.

The Contractor will be responsible for developing and implementing an LRMP in accordance with the measures identified within GLNG Operations LRMP (refer Appendix G). The Contractor's LRMP will set out specific details of rehabilitation goals, objectives, rehabilitation methodologies, indicators and completion criteria.

15.6 Offsets

The GLNG Offset Strategy will be approved and implemented prior to commencing construction.

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