



# SMEC Urban

## Report

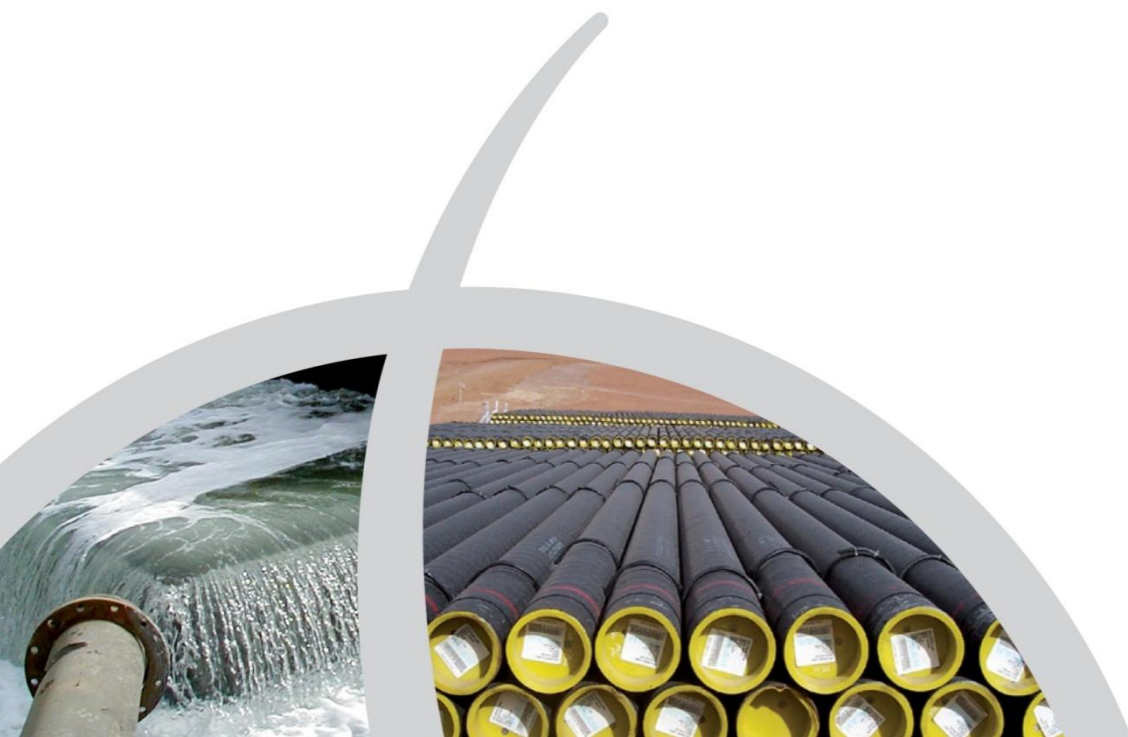
### Safety Management Study for SP AusNet T23 Gas Pipeline adjacent to 151-229 Anglesea Rd, Waurn Ponds

**17 April 2014**

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Revision 1

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## 1 Introduction

### 1.1 Outline

This report documents the processes and result of a Safety Management Study (SMS) held for a section of SP AusNet's Fyansford to Waurn Ponds gas transmission pipeline. The potential impacts to the pipeline are from a proposed property development located south of Hams Road in Waurn Ponds.

The purpose of the SMS Workshop was to identify, review and validate the credibility of potential threats to the pipeline and subsequently identify measures to mitigate and/or control those threats.

The SMS was undertaken in accordance with AS 2885.1 'Pipelines – Gas and Liquid Petroleum – Design and Construction' and documented in a SMS Workshop Spreadsheet. Pipeline documentation referenced in Section 2.8 and the SMS Workshop Spreadsheet in Appendix B forms an integral part of the SMS records.

The Workshop was undertaken on Friday 4<sup>th</sup> April 2014 and was attended by key personnel from SP AusNet, City of Greater Geelong, SMEC Urban, Australian Property Partnership, Energy Safe Victoria and OSD. The presence of representatives from various disciplines ensured that the Workshop was able to consider a wide range of issues and solutions.

## 2 Pipeline Description

The pipeline is a welded steel pipeline operated in accordance with Australian Standard AS 2885.3 – 2012 under provisions of the Pipelines Act 2005 and Pipeline License Number 99.

The pipeline was originally built in 1975 however the section under review was relocated in 2011 due to construction of the Geelong Ring Road.

SP Ausnet is the owner of the pipeline (the Licensee) and is ultimately responsible for ensuring the pipeline is operated and maintained in accordance with the standards, regulations and licensing requirements.

The pipeline is currently used to transport high pressure natural gas between Fyansford and Waurn Ponds.

### 2.1 Description of Pipeline Route under Review

The section of the transmission pipeline under review by this SMS is located between the Geelong Ring Road and the property boundary fence near Hams Road in Waurn Ponds. Drawings included in Appendix C identify the pipeline route and its location.

The offset between the pipeline and the property boundary fence is approximately 16 m. The length of the pipeline being impacted on is approximately 500 meters between chainage 10255 and 9770 as shown in drawings referenced T23-24 and T23-25 in Appendix C.



## 2.2 Pipeline Details

The transmission pipeline has a nominal diameter of DN250 (10”) and transports high pressure gas between Fyansford to Waurn Ponds. Key pipeline details and parameters are included in the Table 1 and Table 2.

**Table 1: Pipeline Information**

Item	Details
Transmission Pipeline Designation	T23
Current Pipeline License Number	99
Pipeline Description	Fyansford to Waurn Ponds gas transmission pipeline
Pipeline Total Length	12.6 km
Pipeline Length under review by this SMS	Approximately 500 m – between chainage 10255 and 9770
Pipeline Commissioned	2011

**Table 2 Pipeline Design Parameters**

Item	Details
Nominal Outside Diameter (OD)	250 mm (10”)
Maximum Allowable Operating Pressure (MAOP)	2,760 kPa
Material	API 5L Grade X42
Pipeline Wall Thickness	6.35 mm Standard Wall 9.27 mm Heavy Wall
Depth of Cover	Minimum 1.2 m
Internal Coating	No
External Coating	Polyethylene for Line Pipe HBE 95 Ceramaguard for exposed areas, Canusa sleeves on pipe joints.

## 2.3 Road Crossings

The gas pipeline crosses Hams Road at chainage 9770. The minimum depth of cover is 1.2m for the road crossing. Existing services including a 1400 mm water main and power cables cross the gas pipeline at Hams Road shown in drawing ‘T23-5-9 250 Gas Pipeline Crossings Hams RD at Anglesea Road’ included in Appendix C.

The proposed development does not intend to construct any road crossings over the existing pipeline. Further, Hams Road no longer crosses the pipeline due to truncation of Hams Road when the Geelong Ring Road Section 4b was constructed which was the same time the pipe was laid.

## 2.4 Other Services

No other services (including telecoms, water, sewage or power etc.) are expected to cross the gas pipeline to service the property. This was confirmed in the SMS Threats Questionnaire (Appendix E) and the SMS Workshop.



## 2.5 Land Use

The pipeline is located within the road reserve which is controlled by the Road Authority Vic Roads.

## 2.6 Landform

The land on the subject site adjacent to the pipeline is generally flat, with little or no elevation difference.

## 2.7 Proposed Development

The site is intended to be used for the construction of standard and medium density residential buildings with ancillary open spaces, road network and infrastructure. Approximate housing numbers (subject to change) for the development are listed below.

- Medium density superlot - 135
- Medium density housing - 78
- Conventional Density housing - 222

The coverage of these properties is expected to meet industry norms. That is, approximately 15 lots per ha for conventional residential and approximately 20 lots per hectare for medium density.

An existing Powercor Waurn Ponds Terminal Station is located outside of the proposed property on the far north east side of the development approximately 650 m away from the pipeline.

According to the Greater Geelong Planning Scheme Map No. 65 the land is currently designated as FZ' Farming Zone'.

## 2.8 Pipeline Referenced Documentation

The following documentation is referenced in this report and has been used as input into the SMS. All documents listed are included in Appendix C.

**Table 3: Pipeline Referenced Documentation**

Document Title	Reference
Pipelines—Gas and liquid petroleum. Part 1: Design and construction	AS 2885.1 - 2012
AS2885 Buried Pipeline Calculations	136100-EL-CAL-001
Threat Questionnaire Rev A	Completed by SMEC Urban
Concept Plan, Hams Road, Waurn Ponds - Rev C (28/03/14) Drawing	3410685P
250 NB Trans P'Line - Aus.Portland Cement to VIC. Portland Cement Drawing	T23-25: Route Plan Rev 0 Note: Drawings is currently under revision by SP AusNet for some minor editing issues.
Geelong North - Waurn Ponds T/P Transmission Pipeline, Waurn Ponds, Geelong Ring Rd, Route Plan Drawing	T23-24 Rev 0 Note: Drawings is currently under revision by SP AusNet for some minor editing issues.
Pipeline Route for T23 Greater Geelong City Drawing	No 10-06:
Road Crossing, 250 Gas Pipeline Crossing Hams Rd at Anglesea Road. Hams Road. Drawing	T23-5-9 Rev C



Document Title	Reference
Greater Geelong Planning Scheme – Local Provision, Zoning Plan for Hams Road,	Map No. 65

**2.8.1 SMS Threats Questionnaire**

Prior to the SMS Workshop, SMEC Urban completed the SMS Threat Questionnaire included in Appendix E. The purpose of the threat questionnaire is to determine the intended use of the land and identify any threats which may impact on the pipeline.

The threats questionnaire showed that the development would not greatly impact on the pipeline. There is no intent to cross the pipeline with third party crossings (for water, sewage, telecoms, power cables etc), all site access to/from the site would be via Hams Road and that all excavation work would be carried out within the boundary fence. There will be minor above ground drainage works and the installation of a footpath proximate to the gas pipe as part of the development of the subject site.

**3 Safety Study Management Process**

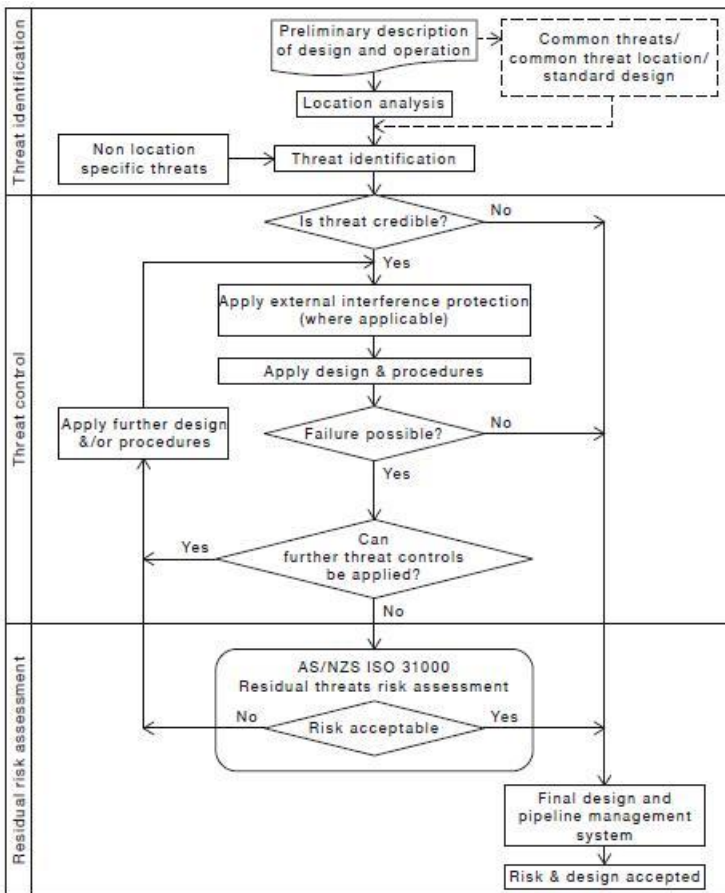
The Safety Management Study (SMS) was undertaken in accordance with the requirements of AS 2885.1. The process used is summarised in Figure 1 which has been taken from AS 2885.1 Figure 2.3.1.

The safety management process requires threat identification and threat mitigation by external interference protection and by design and procedural measures.

Where the measures are considered effective in controlling the threat, the risk from the threat is considered to be controlled. Where controls do not mitigate the risk from the threat to an acceptable level further design investigation will be made and actions recorded during the Workshop.

The pipeline SMS was documented using a Microsoft Excel Spreadsheet. The Spreadsheet is a simple software tool which mirrors the process required by AS 2885.1.

Figure 1: Safety Management Process



Location and Threat Identification – systematic identification of all inherent threats along the pipeline section that could result in hazardous events i.e. damage/release.

Control Identification – identification of all technical, procedural and other measures in place to reduce or mitigate the risk.

Failure Possibility Assessment – If the number of measures in place for the risk control can be proven to eliminate the risk of failure, the risk/design is considered acceptable.

Where design and procedural requirements reduce the risk, but do not eliminate it, the risk must be assessed and managed.

### 3.1 Workshop Basis

It is the intention of AS 2885.1 that the SMS is validated by a Workshop consisting of people experienced in all facets of the pipeline including design, operation, maintenance and safety. External parties including representatives from local council and the developer’s representatives assist in providing details regarding the development.

The intent is that the multidisciplinary Workshop teams introduce a broad range of experience ensuring that all possible threats are identified. The multidisciplinary Workshop team is required to assess each threat, its treatment and the measure of controls and their effectiveness.

Consensus from the Workshop teams on the effectiveness of the control measures, corrective actions and risk management processes provides a sound basis for establishing confidence in the integrity of the Workshop and the quality of the Safety Management Study (SMS).

### 3.2 Pipeline Information

The Workshop was preceded by a presentation of the pipeline design, drawings and accompanying information (pipeline calculations) to ensure that each Workshop participant was properly informed on the nature of the asset and the layout of the development. Hard copies of these documents were available for reference throughout the Workshop.

### 3.3 Information Management

It is essential that the Workshop participants are fully informed of the threats which are being assessed, and their management. For this Workshop, information was presented using a digital projector/screen. It also was used to display the Spreadsheet to Workshop participants as it was being populated.

This presentation methodology was effective in recording information, promoted discussion and resulting in the recording of a list of threats to the pipeline.

### 3.4 Pipeline Geographic Information

A simple approach was taken for the SMS Workshop. The use of aerial imagery, SP AusNet and developer supplied drawings were considered sufficient for identifying surface features associated with the pipeline.

Photo imagery taken from Google Earth, Google Maps and Google Street View were also used in the Workshop. Accuracies of these supplementary visualisation tools were confirmed by the attendees of the Workshop although noted that the Google Street View made use of old imagery from 2007.

### 3.5 External Interference Threat Investigation

Any threat which may cause failure of the pipeline required analysis. The Workshop had representatives from SP AusNet, City of Greater Geelong, SMEC Urban, Australian Property Partnership, Energy Safe Victoria and OSD. There was open discussion regarding external interference threats.

The information gained through Workshop discussions were used for developing an assessment of the external interference threats to the pipeline through activities potentially undertaken in the vicinity of the pipeline.

The Workshop also identified that a number of threats which were outside of the scope for this SMS. These threats included those imposed by the Geelong Ring Road and local railway lines. However, it was agreed and confirmed by SP AusNet, that these threats are managed and assessed by SP AusNet in other Safety Management Studies. The focus of this SMS is to assess the threat imposed on the pipeline directly by the development.

### 3.6 Failure Analysis

The failure analysis involves both the consequence and frequency analysis.

The consequence analysis first involves the calculation of the energy discharge rate and the potential radiation contour for a radiation intensity of 12.6 kW/m<sup>2</sup> and 4.7 kW/m<sup>2</sup> in the event of a full bore pipe rupture.

The calculation is based on quasi-steady state volumetric (or energy) flow 30 seconds after the initiating event (i.e. pipe rupture) as determined by a suitable unsteady hydraulic analysis model, and the relevant equivalent hole size, and assumes that the pipeline is at MAOP at the time of gas release.

The output of the calculation is a measured length for each radiation contour considered. Preliminary work on failure analysis was undertaken prior to the Workshop.



### 3.7 Risk Matrix

AS 2885.1 presents a matrix of severity classes (consequence of failure) and frequency classes for use in risk ranking. The Standard requires each SMS to consider the severity levels and their definition. It was proposed by the SMS Workshop Facilitator to assess risks for threats that are not controlled using the risk matrix in AS 2885.1 Appendix F Table F4.

## 4 Risk Mitigation – Protection Measures

The pipeline has number existing protection measures associated with its design. SP AusNet confirmed that the pipeline had been designed for a ‘T1 Residential’ location even though at the time of the design, applicable Pipeline Location Class was ‘R2 Rural Residential’.

It can be noted, that in accordance with AS 2885.1 Section 5.5.4 the following applies:

- A minimum of 1 physical control and 2 procedural controls shall be applied in R1 and R2 location classes.
- A minimum of 2 physical control and 2 procedural controls shall be applied in T1 and T2 location classes.

At the start of the SMS Workshop some of existing protection measures was discussed as presented in Table 4 and Table 5. In all cases, a minimum of 2 existing physical and 2 procedural controls were in place.

**Table 4: Existing Physical Protection Measures**

Protection Measure	Protection Type	Protection Details
Separation by burial	Separation, depth of cover, exclusion	Minimum of 1.2 m depth of cover.
Wall Thickness	Resistance to penetration	6.35 mm Wall Thickness (WT) is greater than that required by AS 2885.1 and provides acceptable physical protection against penetration. Heavier wall pipe with 9.27 mm WT is located between chainage 10,052 and 9943. The pipeline is a ‘no rupture’ pipeline.
Separation by exclusion	Separation, depth of cover, exclusion	The gas pipeline is separated from the property boundary fence at an offset of 16 m.



**Table 5: Existing Procedural Protection Measures**

Protection Measure	Protection Type	Protection Measure Details
Signage	Procedural Marking	AS 2885.1 Table 4.4.1, provides the recommended signage spacing. For R1 the recommendation is 250 m, for T1 the recommendation is 100 m, but for T1 signs shall be intervisible. Based on the pipeline drawings the maximum spacing between signage is around 250 m.
Buried Marker Tape	Procedural Marking	Marker tape is installed 300 mm above the pipeline. Marking tape is an early warning device should excavation occur above the pipeline.
Patrolling	Patrols, Landowner and other Authority Liaison	SP AusNet and its pipeline maintenance provider Tenix completes pipeline patrols 5 days per week.
Landowner, Occupier and other authority liaison	Patrols, Landowner and other Authority Liaison	SP AusNet carried out third party awareness as an important protection measure.
Permitting	Patrols, Landowner and other Authority Liaison	SP AusNet/Tenix has a permitting process for all works which need to be carried out in the vicinity of the pipeline. The pipeline is also located within the Vic Road Road Reserve requiring further permitting.
Cathodic Protection (CP) System	Pipeline Operations	The pipeline has a CP system installed to mitigate external corrosion.

## 5 Safety Management Study Workshop

### 5.1 General

The Safety Management Study Workshop was completed on Friday 4<sup>th</sup> April 2014 at SP AusNet’s Melbourne Office in Southbank.

The SMS Workshop Spreadsheet was populated prior to the Workshop based on the SMS Threats Questionnaire and details included in the referenced documentation.

The Spreadsheet was managed and maintained throughout the Workshop. Threats, controls and corrective actions were recorded as they were identified to ensure that:

- All matters and issues raised were identified were recorded; and
- Actions were recorded which reflected the consensus positions of the Workshop.

### 5.2 Attendees

The Workshop had representatives from SP AusNet, City of Greater Geelong, SMEC Urban, Australian Property Partnership, Energy Safe Victoria and OSD. OSD provided the SMS Workshop Facilitator.

The Workshop attendees and Workshop agenda recorded in Appendix A.

## 6 SMS Outcomes

### 6.1 Pipeline Location Class

SP AusNet confirmed that the section of the pipeline under review has been designed for T1 Residential but currently has a designation of 'R2 Rural Residential'.

Based on the nature of the property and the population density, it was agreed by Workshop consensus that the Pipeline Location Class should be revised to 'T1 Residential'. The development is to be used for community living with multiple dwellings which exist in close proximity with each other and as such, the Pipeline Location Class is more suited to T1 than R2.

It was agreed at the Workshop that the higher Pipeline Location designation of 'T2 High Density' does not apply since there will be no multistorey high density developments. High density is also permitted in T1 as long as it does not constitute more than 10% of the land use (refer AS 2885.1).

No secondary Location Class has been applied. However, there is a requirement for SP AusNet to be informed of any changes in land usage such as the inclusion of schools, aged care facilities and any other changes which may require inclusion of a secondary location class. This requirement is covered by Item 1014 from the Workshop.

SP AusNet are also required ensure that its Pipeline Integrity Management Plan is updated for T1 and that it reviews the signage requirements for this section. This requirement is covered by Item 1007b from the Workshop.

### 6.2 Pipeline Calculations

OSD completed pipeline calculations prior to the Workshop to provide checks on the pipeline design for Wall Thickness, Road Crossings, Resistance to Penetration and Energy Release Rates. A signed copy of the calculations is included in Appendix D. The results of the calculations are summarised in the sections below.

#### 6.2.1 Pipeline Wall Thickness

A pipeline wall thickness calculation was used to check the design factor and check that the pipeline has sufficient wall thickness. The results are as follows:

- The pipeline has sufficient wall thickness for pressure containment. The required wall thickness is 1.62 mm. Note that the nominated wall thickness is 6.35 mm for standard and 9.27 mm for heavy wall pipe.
- The design factor for the 6.35 mm standard WT is 0.20.
- The Hoop stress at MAOP for the 6.35 mm WT is 20.5% of SMYS meaning the pipeline is 'no rupture' in accordance with AS 2885.1.

#### 6.2.2 Road Crossings

Road crossing calculations have been carried out in accordance with API RP 1102. The calculations have determined that the pipeline is suitable for road crossings with a depth of 1.2 m depth of cover and 900 mm depth of cover for Australian vehicle loads per AS 2885.1. Appendix V.



The existing road crossing at Hams Road was reviewed in the Workshop and agreed that there would be no significant alterations to Hams Road for the development. In addition, no new road crossings are required to cross the pipeline for access to the proposed property for example.

### 6.2.3 Resistance to Penetration

The resistance to penetration calculation is carried out per Appendix M of AS 2885.1 and is used to determine the pipelines resistance to penetration for typical excavator types up to 55 tonnes.

The teeth most commonly found on excavators are either Twin Pointed Tiger Teeth (TPTT) and General Purpose Teeth (GPT). Single Point Penetration Teeth (SPPT) are usually restricted to machines used specifically for hard ground conditions.

The calculations used a 'Bucket Force Multiplier' value of 1.0 for locations where penetration resistance can be reasonably relied on to satisfy the requirements of the safety management study for 'no puncture'. The Resistance to Penetration calculations are included in Appendix D. The results show that:

1. No GPT excavators up to and including 55 tonnes will penetrate the pipeline.
2. A TPTT excavator 35 tonnes and above can puncture the pipeline.
3. A SPPT excavator 15 tonnes and above can puncture the pipeline.

Based on the resistance to penetration assessment it is recommended that no GPT excavators 55 tonnes and above, SPPT excavators 15 tonnes and above or TPTT excavators 35 tonnes be used in the vicinity of the pipeline.

During the Workshop the threat from excavators was considered. There is a requirement action 1007a to include a boundary fence to exclude machinery access to the pipeline and for property boundary identification. Additionally, the boundary fence is 16 m offset to the gas pipeline i.e. a physical protection by separation. The pipeline is also buried at a minimum depth of cover of 1.2m.

### 6.2.4 Energy Discharge Rates

The energy discharge calculation is carried out per AS 2885.1 and API RP 521.

Table 6: Energy Discharge Rates Results

HOLE / LEAK PUNCTURE STEADY STATE FLOW									
Hole Size (mm)	Percent of Pipe Dia.	Tooth Type	Credible Penetration Failure?	Flow Rate		R <sub>12.6 kW/m<sup>2</sup></sub> (m)	R <sub>14.7 kW/m<sup>2</sup></sub> (m)	Acceptance	
				(GJ/s)	(TJ/d)				
15	6%	N/A	NO						Pass (N/A)
25	10%	SPTT	YES	0.07	6.0	10.4	17.4		Pass
30	12%	SPTT	YES	0.10	8.6	12.5	20.9		Pass
35	13%	SPTT	YES	0.14	11.7	14.5	24.4		Pass
40	15%	N/A	NO						Pass (N/A)
45	17%	N/A	NO						Pass (N/A)
55	21%	SPPT	TBC	0.33	28.8	22.8	38.4		Pass
60	23%	SPPT	TBC	0.40	34.3	24.9	41.8		Pass
65	25%	SPPT	TBC	0.47	40.2	27.0	45.3		Pass
75	29%	N/A	NO						Pass (N/A)
85	33%	N/A	NO						Pass (N/A)
90	35%	SPPT	TBC	2.08	179.9	57.0	95.8		Pass
95	36%	N/A	NO						Pass (N/A)
100	38%	N/A	NO						Pass (N/A)
110	42%	TPTT	YES	2.53	218.8	62.9	105.7		Pass
120	46%	TPTT	YES	2.72	235.2	65.2	109.6		Pass
125	48%	TPTT	YES	2.79	241.4	66.1	111.0		Pass

The hole size range is referenced from AS2885.1 table M3 - credibility is referenced from Penetration Resistance Calculations Equations from AS2885.1 Appendix Y were used for steady state leak flow rates and radiation contours



The results of the Energy Discharge calculations are as follows:

- For full bore rupture the energy discharge rates is 3.4 GJ/s. The measurement length to 4.7 kW/m<sup>2</sup> is 120 m and 74 m for 12.6 kW/m<sup>2</sup>. Note that full bore rupture is not credible since the pipeline hoop stress at MAOP is less than 30% of SMYS.
- A hole size of 125 mm from a TPTT will result in an energy release rate of 2.79 GJ/s. The measurement length to 4.7 kW/m<sup>2</sup> is 111.0 m and 66.1 m for 12.6 kW/m<sup>2</sup>. As detailed in Section 6.2.3 a number of physical controls will prevent excavators working in the vicinity of the pipeline so the threat from penetration due to excavator activities has been controlled.
- The energy release rate in all cases is less than 10 GJ/s which is the maximum requirement of ‘T1 Residential’ Location per AS 2885.1.

### 6.3 SMS Workshop Findings

The SMS Spreadsheet documents the threats considered in the SMS, the controls and actions required.

A total of 19 threats to the pipeline were identified. 12 of the 19 threats were determined ‘Not Credible’ with the justifications why included in the Spreadsheet.

The other 7 threats were determined controlled both by existing physical and procedural controls. 5 of these threats required further design and procedural protection measures detailed in Table 7.

Table 7: SMS Workshop Actions

Item No.	Threat Description	Actions	Responsibility	Action Status
1002	Utility Crossing - Subsurface Drains - Cause inundation by excavation	Property developer to consider subsurface drain design so as not to impact on the pipeline, and consult with SP AusNet during the design phase.	Vendor of the property i.e. the property developer.	Open
1007a	Excavation outside property boundary near pipeline.	Boundary fence to exclude machinery access to the pipeline and for property boundary identification.	Vendor of the property i.e. the property developer	Open
1007b	Excavation outside property boundary near pipeline.	SP AusNet to consider increased signage along the pipeline affected area and Location Class designation for T1 Residential.  Note - SP AusNet to confirm the Integrity Management Plan conforms to T1 requirements in this area.	SP AusNet	Open
1014	Construction activities for the proposed development parallel and over gas pipeline	Referral of the property detailed design plans to SP AusNet.	City of Greater Geelong – Council	Open
1019	Land Use change to sensitive use within measurement length.	Planning permit applications for future usage for the development to be notified to SP AusNet for review.	City of Greater Geelong – Council	Open

## 7 Conclusions

The SMS Workshop gave detailed consideration to the threats identified for the section of pipeline under review in this SMS.

Based on the pipeline documentation used and discussions held at the SMS Workshop, all threats identified have either been determined as non-credible or have been controlled. No threats required failure analysis or risk assessment.

A total of 5 Actions are required to ensure that additional design and procedural measures are incorporated.

The SMS Workshop has determined by consensus that the Pipeline Location Class for the section of pipeline reviewed is to be amended to T1 Residential. The Workshop concludes that there are sufficient procedural and physical controls for a T1 designation. This is an increase to the current Pipeline Location Class which is R2 Rural Residential.

Based on this outcome, SP AusNet is required to review its internal documentation and consider any additional requirements such as signage for T1 compliance per AS 2885.

### 7.1 Close Out of Actions

This SMS cannot be considered complete until the Actions are implemented and closed out. It is the responsibility of the organisation assigned to confirm the methods, procedures and/or designs initiated to demonstrate closure of each Action item.

However, the close out of the Actions is not intended to impede any re-zoning applications required by the developer. The SMS process is an on-going one and the Actions are meant to be implemented during further property development design and construction activities.



# Appendix A

## SMS Workshop Agenda and Signed Attendess List

# **AS 2885 SAFETY MANAGEMENT STUDY WORKSHOP**

**Friday 4<sup>th</sup> April 2014**

**10 am to 1 pm**

**Location: SP AusNet Office: Level 31, 2 Southbank Boulevard,  
Southbank**

## **AGENDA**

1. Introductions
2. Overview of Pipeline and Development
3. Results of the Buried Pipeline Calculations
4. Threat Identification per Figure 1 below.
5. Threat Control
  - a. Prevention by Design and/or Procedure
6. Residual Risk Assessment
7. Close

The following figure details the process to be followed in completion of the Safety Management Study (SMS).

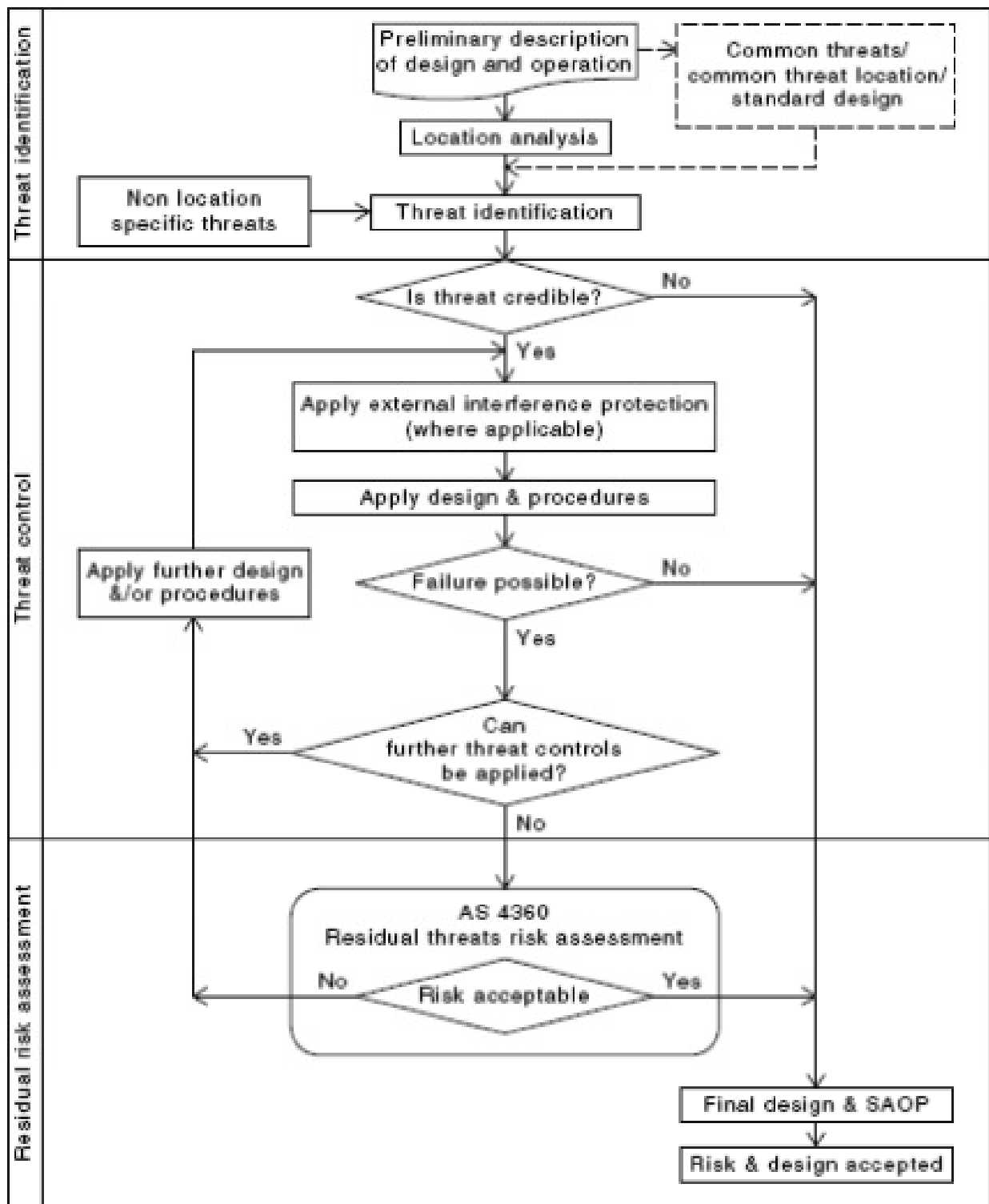


Figure 1 - Pipeline Safety Management Process





# Appendix B

## SMS Workshop Spreadsheet



**SMS for SP AusNet T23 Gas Pipeline Near Hams Road**  
**OSD Job Number: 136102**  
**Gas Pipeline: 250NB Tran P'Line - Aus. Portland Cement to VIC**

**General Pipeline Information**

**Assessment Type:** Initial Safety Management Study per AS 2885.1. **Revision No:** A

**Reference documents:** AS 2885.1 - 2012 Pipelines—Gas and liquid petroleum. Part 1: Design and construction  
AS2885 Buried Pipeline Calculations 136100-EL-CAL-001  
Threat Questionnaire Rev A - Completed by SMEC  
Drawing: Concept Plan, Hams Road, Waurm Ponds - Rev C (28/03/14)  
Drawing Ref T23-25: Route Plan, 250 NB Trans P'Line - Aus.Portland Cement to VIC. Portland Cement  
Drawing Ref T23-24: Geelong North - Waurm Ponds T/P Transmission Pipeline, Waurm Ponds, Geelong Ring Rd, Route Plan  
Drawing Ref No 10-06: Pipeline Route for T23 Greater Geelong City  
Drawing Ref T23-5-9 Rev C ' Road Crossing, 250 Gas Pipeline Crossing Hams Rd at Anglesea Road. Hams Road.  
Zoning Plan\_Hams Road, Map No. 65

<b>Diameter</b>	273.1 mm	<b>Length (approx.)</b>	approx 500m	<b>Steel Grade</b>	API 5L Grade X42	<b>MAOP</b>	2.760 MPa	
<b>Standard WT</b>	6.35 mm	<b>Critical Defect</b>	N/A	<b>Fracture Toughness</b>	N/A	<b>% Hoop Stress at MAOP</b>	20.50%	Hoop Stress <30% SMYS Per AS 2885.1.

*Calculations for this SMS are included in 136100-EL-CAL-001 - AS 2885 Buried Pipeline Calculations*



**Initial SMS for T23 Gas Pipeline Near Hams Road**  
**OSD Job Number: 136102**  
**Gas Pipeline: 250NB Tran P'Line - Aus. Portland Cement to VIC**

**Pipeline Sections**

<b>Assessment Type:</b>	Initial Safety Management Study per AS 2885.1.	<b>Revision No:</b>	A	<b>Location Class</b>	Residential (T1) as Primary with no secondary class
<b>Diameter</b>	273.1 mm	<b>Length (approx.)</b>	appox 500m	<b>Steel Grade</b>	API 5L Grade X42
				<b>MAOP</b>	2.760 MPa
Section ID 1	CH: 10,335	to	CH: 9,813	<b>Description:</b>	The DN250 pipeline routes between the Geelong Ring road and the proposed development at Waurm Ponds. The offset between the pipeline and the proposed property boundary fence is 16 m. The length of the pipeline being impacted on is approximately 500 m. No new pipeline crossings are required as part of the proposed property development. Access to the property will be via Hams Road.
				<b>Land Use:</b>	The pipelines' location classification is currently Residential T1 per AS 2885.1. At current stages of planning, the land is intended for residential purposes with ancillary open spaces, road network and infrastructure. Approximate numbers (subject to change): - Medium density superlot - 135 - Medium density housing - 78 - Conventional Density housing - 222
				<b>Current Zoning</b>	The Development is current zoned for FZ Farming Zone.



**SMS for SP AusNet T23 Gas Pipeline Near Hams Road**  
**OSD Job Number: 136102**

No.	Threat	Credible Threat ?	External Interference Protection	Prevention by Design and/or Procedures	Failure mode if controls fail	Failure Analysis Required ?	Hazardous Event ?	Comments	Frequency	Severity	Risk	Actions	Action No.	Resp Person
1001	Utility Crossings - Buried Third Party Services	No	Physical controls - Separation by burial (1200mm DOC), Resistance to Penetration (Wall Thickness) Procedural Controls - One call service, marking, patrolling 5 days per week, permitting from SP Ausnet / Tenix											
1002	Utility Crossing - Subsurface Drains - Cause inundation by excavation	Yes	Physical controls - Separation by burial (1200mm DOC), Resistance to Penetration (Wall Thickness) Procedural Controls - One call service, marking, patrolling 5 days per week, permitting from SP Ausnet / Tenix	Min. vertical separations based on SP AusNet Condition for Works near Gas Transmission Pipelines TS2607.2. Property developer to consider subsurface drain design so as not to impact on the pipeline, and consult with SP AusNet during the design phase.								Property developer to consider subsurface drain design so as not to impact on the pipeline, and consult with SP AusNet during the design phase.	1002	Vendor of the property
1003	New Utility Crossing for the proposed development	No	Physical controls - Separation by burial (1200mm DOC), Resistance to Penetration (Wall Thickness) Procedural Controls - One call service, marking, patrolling 5 days per week, permitting from SP Ausnet / Tenix											
1004	Utility Crossing - Overhead Power Lines	No	Physical controls - Separation by burial (1200mm DOC), Resistance to Penetration (Wall Thickness) Procedural Controls - One call service, marking, patrolling 5 days per week, permitting from SP Ausnet / Tenix											
1005	Road construction crossing over operating pipeline.	No	Physical controls - Separation by burial (1200mm DOC), Resistance to Penetration (Wall Thickness) Procedural Controls - One call service, marking, patrolling 5 days per week, permitting from SP Ausnet / Tenix											
1006	Excavation by 3rd party.	Yes	Physical controls - Separation by burial (1200mm DOC), Resistance to Penetration (Wall Thickness) Procedural Controls - One call service, marking, patrolling 5 days per week, permitting from SP Ausnet / Tenix	Covered in existing pipeline SP AusNet SMS for non specific threats.										



**SMS for SP AusNet T23 Gas Pipeline Near Hams Road**  
**OSD Job Number: 136102**

No.	Threat	Credible Threat ?	External Interference Protection	Prevention by Design and/or Procedures	Failure mode if controls fail	Failure Analysis Required ?	Hazardous Event ?	Comments	Frequency	Severity	Risk	Actions	Action No.	Resp Person
1007a			Physical controls - Separation by burial (1200mm DOC), Resistance to Penetration (Wall Thickness)	Boundary fence to exclude machinery access to the pipeline and for property boundary identification.								Boundary fence to exclude machinery access to the pipeline and for property boundary identification.	1007a	Vendor of the property
1007b	Excavation outside property boundary near pipeline.	Yes	Procedural Controls - One call service, marking, patrolling 5 days per week, permitting from SP Ausnet / Tenix	SP AusNet to consider increased signage along the pipeline affected area and Location Class designation for T1 Residential. Note - SP AusNet to confirm the Integrity Management Plan conforms with T1 requirements in this area.								SP AusNet to consider increased signage along the pipeline affected area and Location Class designation for T1 Residential. Note - SP AusNet to confirm the Integrity Management Plan conforms with T1 requirements in this area.	1007b	SP AusNet
1008	Ripping and ploughing for cable installation above the pipeline.	No	Physical controls - Separation by burial (1200mm DOC), Resistance to Penetration (Wall Thickness) Procedural Controls - One call service, marking, patrolling 5 days per week, permitting from SP Ausnet / Tenix											
1009	Installation of posts or poles for fencing.	Yes	Physical controls - Separation by burial (1200mm DOC), Resistance to Penetration (Wall Thickness), Separation by Offset from Property Fence line (16m). Procedural Controls - One call service, marking, patrolling 5 days per week, permitting from SP Ausnet / Tenix											
1010	Tree growing over top of pipeline	No	Physical controls - Separation by burial (1200mm DOC), Resistance to Penetration (Wall Thickness) Procedural Controls - One call service, marking, patrolling 5 days per week, permitting from SP Ausnet / Tenix											
1011	Restricted access to ROW	No	Physical controls - Separation by burial & Heavy WT, Resistance to Penetration - concrete slabs and WT Procedural Controls - One call service, marking. Land owner liaison											



**SMS for SP AusNet T23 Gas Pipeline Near Hams Road**  
**OSD Job Number: 136102**

No.	Threat	Credible Threat ?	External Interference Protection	Prevention by Design and/or Procedures	Failure mode if controls fail	Failure Analysis Required ?	Hazardous Event ?	Comments	Frequency	Severity	Risk	Actions	Action No.	Resp Person
1012	Pipeline is in close proximity to proposed property development - 3rd party activities/maintenance result in pipe failure.	Yes	Physical controls - Separation by burial (1200mm DOC), Resistance to Penetration (Wall Thickness)  Procedural Controls - One call service, Safety Management Plan, patrolling 5 days per week, SOP, SP AusNet Pipeline Management plan.	Covered in existing pipeline SP AusNet SMS for non specific threats.										
1013	Pipeline is in close proximity to proposed property development - External Corrosion resulting in pipe failure	No	Physical controls - Barrier (Coating), WT, Cathodic Protection.  Procedural Controls - Pipeline Management plan, DCVG required 5 yearly by SP AusNet. Local CP Test Posts	DCVG required 5 yearly by SP AusNet. Local CP Test Posts										
1014	Construction activities for the proposed development parallel and over gas pipeline	No	Physical controls - Separation by burial (1200mm DOC), Resistance to Penetration (Wall Thickness)  Procedural Controls - One call service, marking, patrolling 5 days per week, permitting from SP Ausnet / Tenix	The Pipelines Act requires no works within 3 m of the pipeline. No construction work planned within 16 m of the pipeline.  Referral of detailed design plans to SP AusNet.							Referral of detailed design plans to SP AusNet.	1014	Geelong City Council	
1015	Electrical substation within close proximity to pipeline - threat to the cathodic protection of the pipeline.	No	Physical controls - Separation by burial (1200mm DOC), Resistance to Penetration (Wall Thickness)  Procedural Controls - One call service, marking, patrolling 5 days per week, permitting from SP Ausnet / Tenix	No electrical substation proposed.										
1016	Damage from bogged vehicles over the pipeline.	No	Physical controls - Separation by burial (1200mm DOC), Resistance to Penetration (Wall Thickness)  Procedural Controls - One call service, marking, patrolling 5 days per week, permitting from SP Ausnet / Tenix	All vehicle access via Hams Road. Vehicle access not permitted past the boundary fence line.										
1017	Nearby Blasting	No	Physical controls - Separation by burial (1200mm DOC), Resistance to Penetration (Wall Thickness)  Procedural Controls - One call service, marking, patrolling 5 days per week, permitting from SP Ausnet / Tenix											



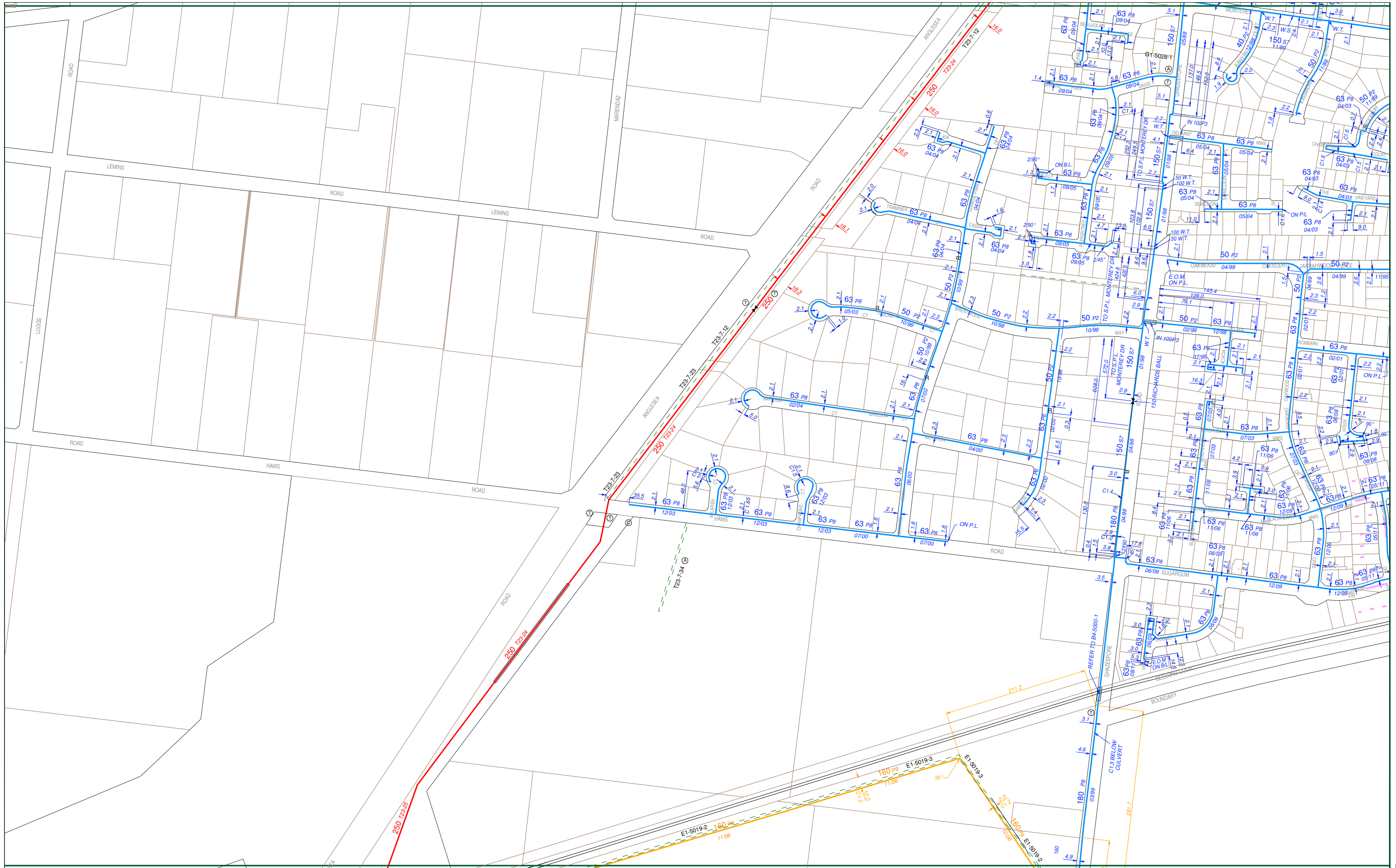
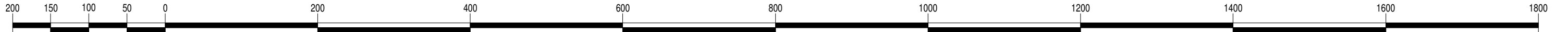
**SMS for SP AusNet T23 Gas Pipeline Near Hams Road**  
**OSD Job Number: 136102**

No.	Threat	Credible Threat ?	External Interference Protection	Prevention by Design and/or Procedures	Failure mode if controls fail	Failure Analysis Required ?	Hazardous Event ?	Comments	Frequency	Severity	Risk	Actions	Action No.	Resp Person
1018	Intentional Damage to the Pipeline.	Yes	Physical controls - Separation by burial (1200mm DOC), Resistance to Penetration (Wall Thickness) Procedural Controls - One call service, marking, patrolling 5 days per week, permitting from SP Ausnet / Tenix	Covered in existing pipeline SMS for non specific threats.										
1019	Land Use change to sensitive use within measurement length.	Yes	Physical controls - Separation by burial (1200mm DOC), Resistance to Penetration (Wall Thickness) Procedural Controls - One call service, marking, patrolling 5 days per week, permitting from SP Ausnet / Tenix	Planning permit applications for future usage for the development to be notified to SP AusNet for review.								Planning permit applications for future usage for the development to be notified to SP AusNet for review.	1019	Geelong City Council



# Appendix C

## Referenced Drawings and Documentation



**NOTICE**

SP AUSNET HAS TAKEN CARE TO ENSURE THAT THE LOCATION OF GAS MAINS SHOWN ON THIS PLAN ARE ACCURATE. HOWEVER, SOME VARIATIONS FROM RECORDS DO EXIST AND COMPLETE ACCURACY IS NOT GUARANTEED. IT IS ESSENTIAL THAT THE POSITION OF PIPES BE PROVED ON SITE BY HAND EXCAVATION. IT IS AN OFFENCE UNDER THE GAS INDUSTRY ACT 1994 TO DAMAGE ANY GAS PIPE OR TO EXPOSE ANY GAS PIPE WITHOUT AUTHORITY. GAS PIPELINES NOT BELONGING TO SP AUSNET ARE SHOWN ON THIS PLAN IN CONTRASTING COLOURS. THE LOCATION, SIZE AND FUNCTION OF THESE PIPELINES ON THIS PLAN IS INDICATIVE ONLY, AND MUST NOT BE RELIED UPON. SUCH INFORMATION MUST BE VERIFIED WITH THE OWNER OF THE PIPELINES. SP AUSNET SHALL NOT BE LIABLE FOR ANY LOSS DAMAGE CLAIM OR DEMAND INCURRED EITHER DIRECTLY OR INDIRECTLY RESULTING FROM ANY ACT OR OMISSION WHICH WAS MADE IN RELIANCE IN WHOLE OR IN PART UPON THIS PLAN.

**PRESSURE RANGES**

PLANNED	UP TO 3kPa	-----
LOW	15kPa - 70kPa	-----
MEDIUM	140kPa - 515kPa	-----
HP1	515kPa - 1050kPa	-----
HP2	1050kPa - 2760kPa	-----
TRANSMISSION SP-AUSNET	IN EXCESS OF 2760 kPa	-----
TRANSMISSION OTHERS		-----

PRODUCT OF AMFM

MUNICIPALITY OF  
**GREATER GEELONG CITY**

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2012 (C)  
LEGEND OVERLEAF



SHEET INDEX	CORIO	10-07	11-07
	09-07	10-06	11-06
	09-05	10-05	11-05

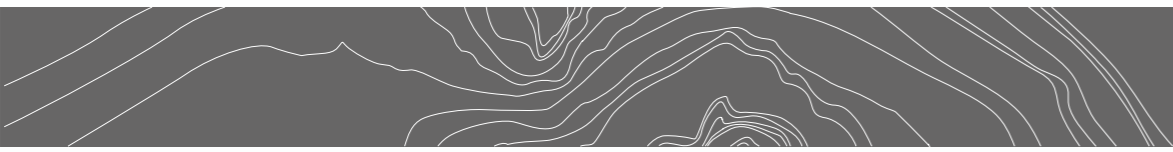
MELWAY REFERENCE  
MAP 464  
REVISION DATE: 25/06/2012

No CORIO 2500  
**10-06**



- LEGEND**
- Subject Site
  - Potential Open Space including Waterway, Water Treatment and Retardation
  - Potential Standard Density Residential
  - Potential Medium Density Residential
  - Potential Shared Path
  - Buffer around Powercor Terminal
  - AusNet Gas Transmission Pipeline
  - 90m Buffer Zone

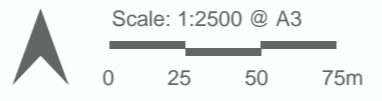
**Note:**  
 The approximate pipeline location has been determined based on Greater Geelong City Drawing Corio 2500 10-06. If required, the pipeline's location will be proven prior to any construction works being carried out in the vicinity of the pipeline.



**Concept Plan**  
 Hams Road, Waurn Ponds



Revision	Date	Description	Checked
B	26/02/14	Additional notes	CD / 26/02/14
C	28/03/14	90m buffer gas pipeline and distance of gas pipeline to site boundary annotated	RJ / 28/03/14



ref.: 3410685P  
 date: 28 March 2014  
 rev.: C  
 drawn: DS  
 checked: RJ

please note:  
 This plan is based on preliminary information only and may be subject to change as a result of formal Council/Authority advice, detailed site investigations and confirmation by survey

planning & urban design  
 melbourne - tel 9869 0800  
 © smec australia pty ltd  
 abn 47 065 475 149  
 trading as smec urban

FROM CH 10052.100 TO CH 10429.259 6.35mm wt  
 FROM CH 10468.170 TO CH 10679.031 6.35mm wt  
 FROM CH 10429.259 TO CH 10468.170 9.27mm wt

**SPECIFICATION FOR 250 NB RELOCATED STEEL PIPELINE—August 2011**  
 PIPE: 273.0 mm OD x 6.35 mm & 9.27mm wt  
 API STANDARD 5L GRADE X42  
 COATING: POLYETHYLENE FOR LINE PIPE HBE 95 CERAMAGUARD FOR EXPOSED AREAS. CANUSA SLEEVES ON PIPE JOINTS.  
 FIELD WELDING: AS 2885.2 - 2007  
 TESTING: HYDROSTATICALLY TESTED  
 MAX 7320 kPa

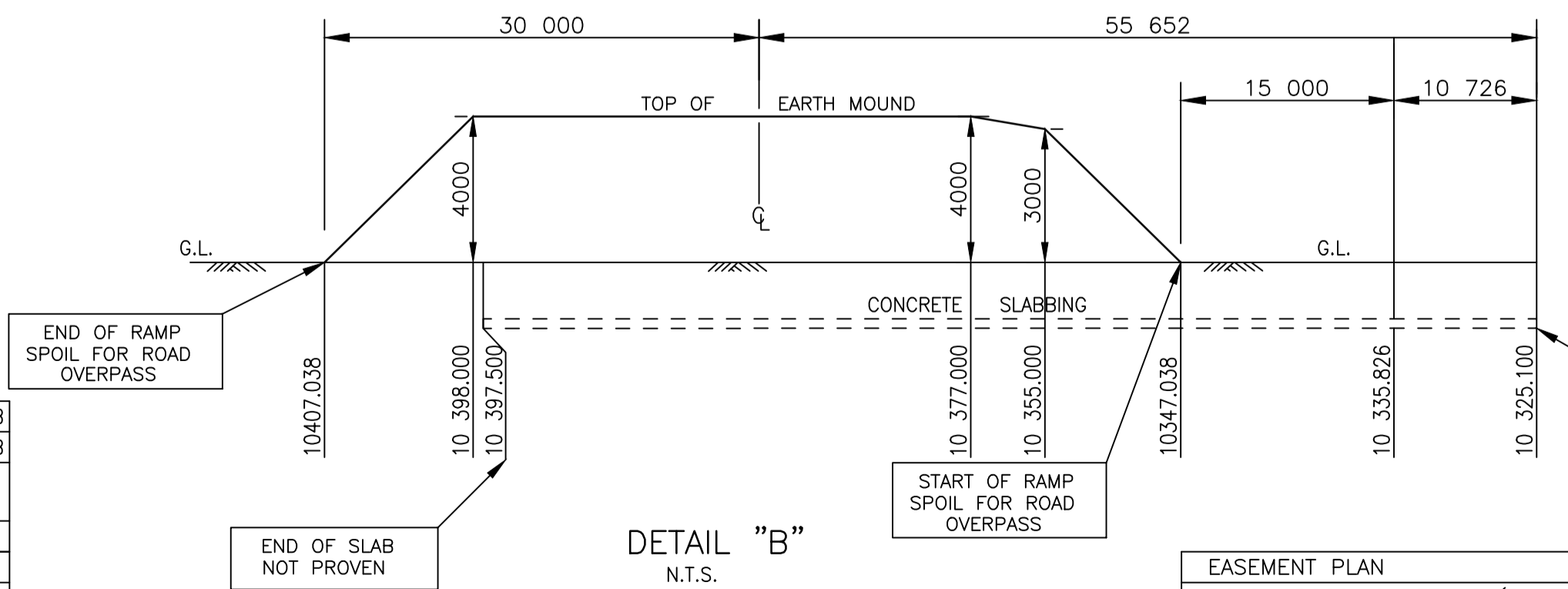
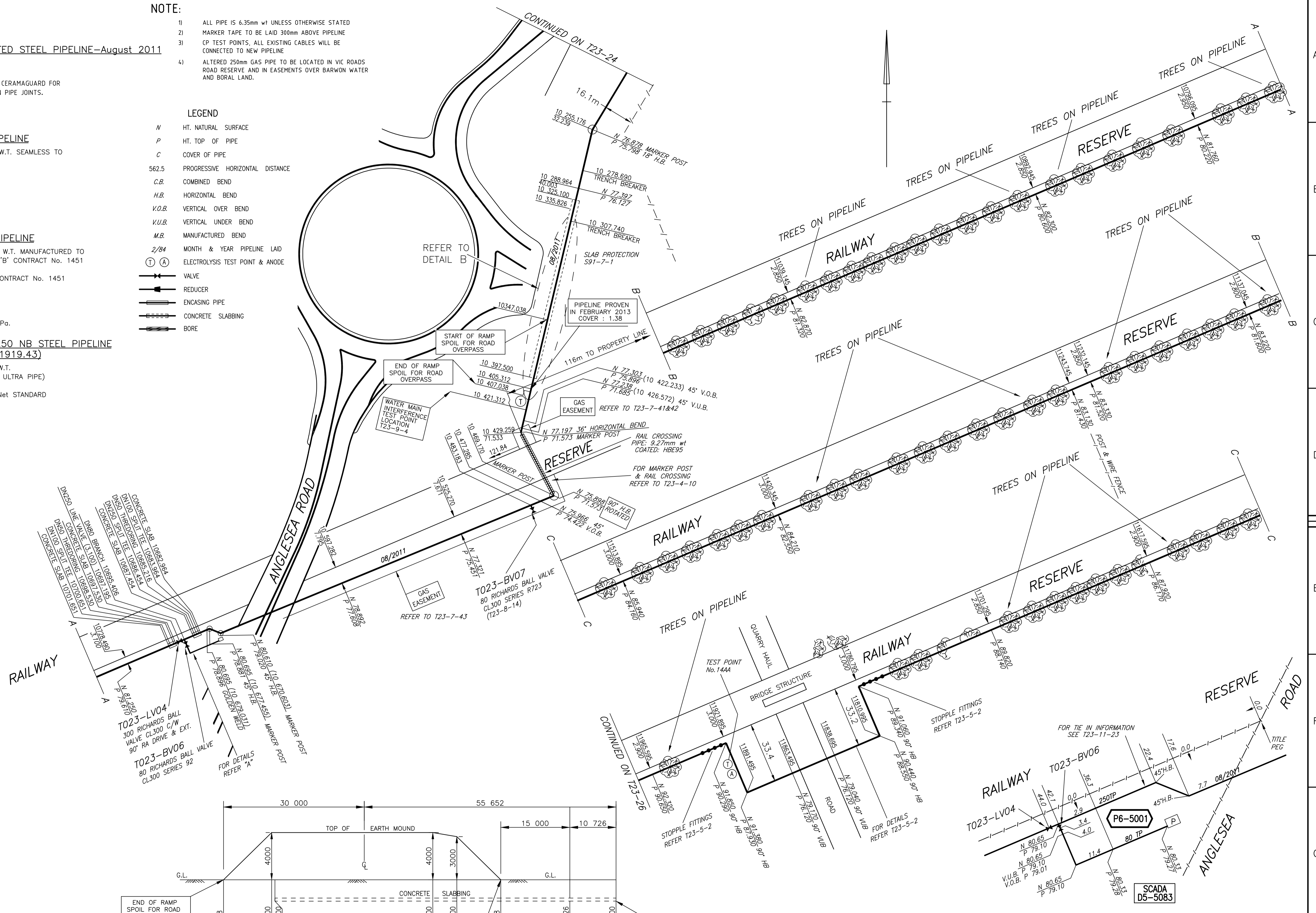
**SPECIFICATION FOR 80 NB STEEL PIPELINE**  
 PIPE: 88.9mm O.D. X 5.49 mm W.T. SEAMLESS TO ASTM A106 GRADE 'B'  
 COATING: EXTRUDED POLYETHYLENE  
 FIELD WELDING: AS 2885-2 2002  
 TESTING: HYDROSTATICALLY TESTED

**SPECIFICATION FOR 250 NB STEEL PIPELINE**  
 PIPE: 273.0mm O.D. X 6.38 mm W.T. MANUFACTURED TO A.P.I. STANDARD 5L GRADE 'B' CONTRACT No. 1451  
 COATING: EXTRUDED POLYETHYLENE CONTRACT No. 1451  
 FIELD WELDING: A.S. C.B. 28 - 1972  
 TESTING: HYDROSTATICALLY TESTED  
 MIN. 6488kPa MAX. 7612kPa.

**SPECIFICATION FOR ALTERATION TO 250 NB STEEL PIPELINE (FROM Ch. 11775.20 TO Ch. 11919.43)**  
 PIPE: 273.0mm O.D. X 6.4 mm W.T. A.P.I. 5L GRADE X42 (PSL2 ULTRA PIPE)  
 COATING: YELLOW JACKET TO SP AusNet STANDARD  
 FIELD WELDING: A.S. 2885.2  
 TESTING: HYDROSTATICALLY TESTED  
 7612kPa.

**NOTE:**  
 1) ALL PIPE IS 6.35mm wt UNLESS OTHERWISE STATED  
 2) MARKER TAPE TO BE LAID 300mm ABOVE PIPELINE  
 3) CP TEST POINTS, ALL EXISTING CABLES WILL BE CONNECTED TO NEW PIPELINE  
 4) ALTERED 250mm GAS PIPE TO BE LOCATED IN VIC ROADS ROAD RESERVE AND IN EASEMENTS OVER BARWON WATER AND BORAL LAND.

**LEGEND**  
 N HT. NATURAL SURFACE  
 P HT. TOP OF PIPE  
 C COVER OF PIPE  
 562.5 PROGRESSIVE HORIZONTAL DISTANCE  
 C.B. COMBINED BEND  
 H.B. HORIZONTAL BEND  
 V.O.B. VERTICAL OVER BEND  
 V.U.B. VERTICAL UNDER BEND  
 M.B. MANUFACTURED BEND  
 2/84 MONTH & YEAR PIPELINE LAID  
 (T) (A) ELECTROLYSIS TEST POINT & ANODE  
 VALVE  
 REDUCER  
 ENCASING PIPE  
 CONCRETE SLABBING  
 BORE

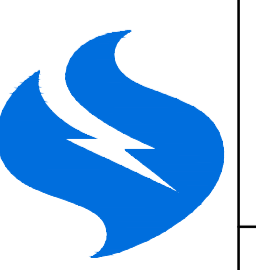


NO.	REF.	DATE	REVISION	DRN.	CKD.	APP.
O	C-6	12-02-14	CLIENT COMMENTS INCLUDED	HA	RG/JL	K.C.B
N	C-6	19-07-13	ROUND ABOUT ADDED AND SURFACE LEVELS UPDATED	HA	RG/JL	K.C.B
M	C-5	6-03-13	START OF SLABBING WAS TO 301.141 START OF RAMP SPOIL ADDED // DETAIL 'B' ADDED	JW	Z.I.	S.P.
L	D-6	10-04-12	116m TO PROPERTY LINE CHANGED FROM TEST POINT TO BEND	BMcP	K.C.B	D.G
K	8-02-12		AS BUILT	BMcP	K.C.B	D.G
H	E-5	30-3-11	CP INTERFERENCE TEST POINT ADDED	BMcP	K.C.B	J.D.R
G	16-3-11		250TP RELOCATION APPROVED FOR CONSTRUCTION	BMcP	K.C.B	J.D.R
F	G-6	29-4-09	TEST POINT & ANODE ADDED AT BLUE CIRCLE	BMcP	S.S.	S.P.
E	G-6,7	4-2-09	BLUE CIRCLE ROAD CROSSING ADDED	BMcP	S.S.	S.P.
D	F-3	17-1-08	REDRAWN (CAD) INCLUDING ALL PREVIOUS REVISIONS NEW LINE VALVE & REGULATOR (P6-5001) ADDED	BMcP	M.C.	S.S.

CORROSION TEST POINT—RAIL CROSSING ANGLESEA RD	T23-9-4
CONCRETE SLAB INSTALLATION	S91-7-1
80 BRANCH VALVE T23-BV07	T23-8-14
ANGLESEA ROAD TIE IN	T23-11-23
RAIL CROSSING DRAWING	T23-4-10

EASEMENT PLAN	T23-7-40to43
ROAD CROSSING DETAILS (BLUE CIRCLE)	T23-5-2
LICENCE NUMBER	99
KEY PLAN	A4-100-2
RAIL CROSSING DRAWING	T23-4-1
LINE VALVE & OFFTAKE VALVE ANGLESEA ROAD	T23-8-8
REGULATOR	P6-5001

LOCATION	SCALE: AS SHOWN
WAURN PONDS	MELWAY 464, A-12/F-12
FIELD AREA	DISTRICT PLAN No. CORIO 09-05-10-05,06
FIELD BOOK	DRAWN B.McPHERSON 16-1-2008 CHECKED M.CAMERON
LEVEL DATUM	© SP AusNet
A.H.D.	



**ROUTE PLAN** BARRABOOL  
**250NB TRANS P'LINE—AUS. PORTLAND CEMENT TO VIC. PORTLAND CEMENT**

RUSSELL LEE APPROVED  
 JOHN UREN Client Approval/If req'd  
 R T23-25 O

FIELD RECORDING BY K.A. REED PTY. LTD.

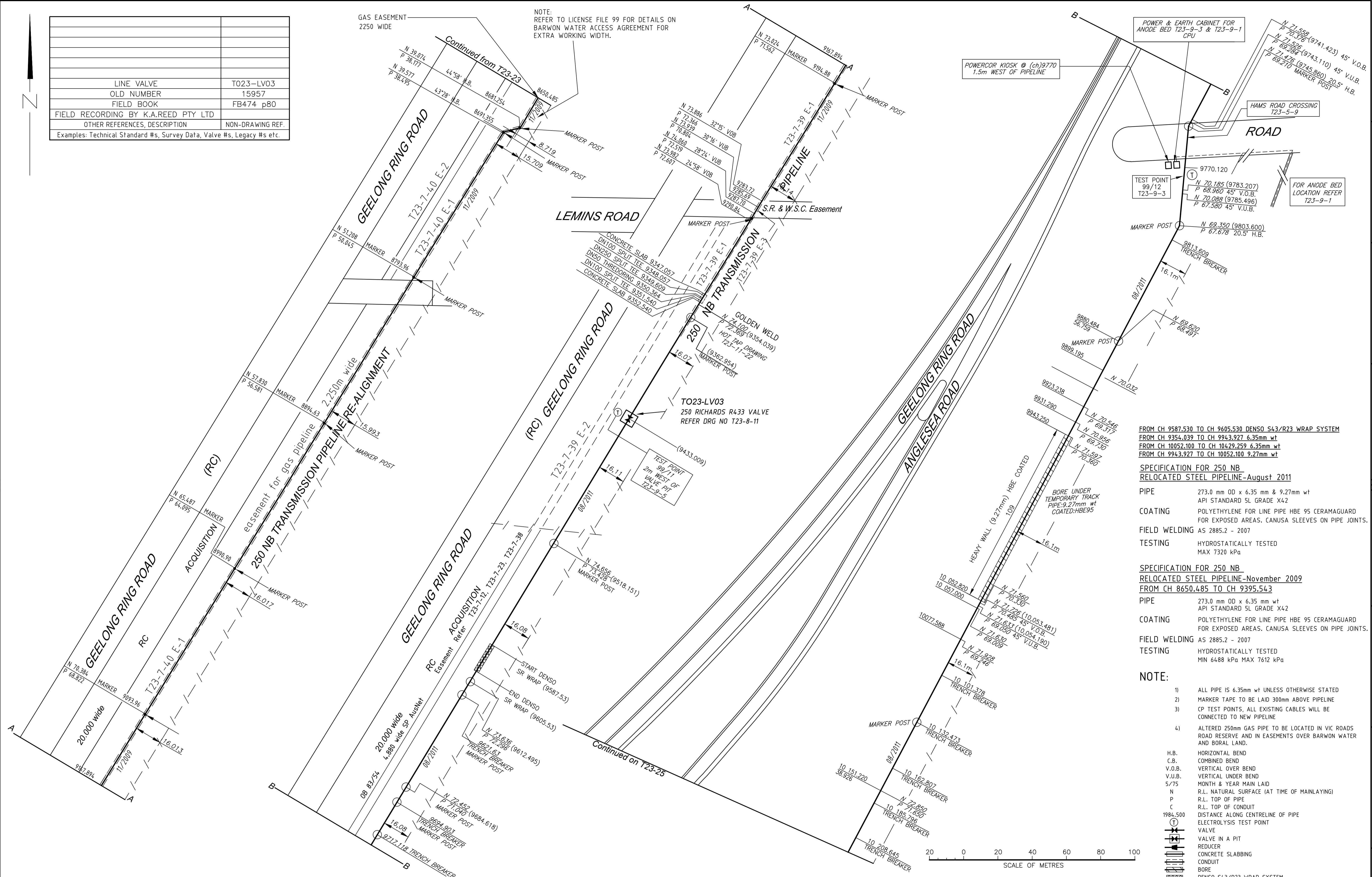
20 0 20 40 60 80 100

DETAIL "A"  
 REFER T23-8-7 FOR GREATER DETAIL  
 N.T.S.

LINE VALVE	T023-LV03
OLD NUMBER	15957
FIELD BOOK	FB474 p80
FIELD RECORDING BY	K.A. REED PTY LTD
OTHER REFERENCES, DESCRIPTION	NON-DRAWING REF.
Examples: Technical Standard #s, Survey Data, Valve #s, Legacy #s etc.	

GAS EASEMENT  
2250 WIDE

NOTE:  
REFER TO LICENSE FILE 99 FOR DETAILS ON  
BARWON WATER ACCESS AGREEMENT FOR  
EXTRA WORKING WIDTH.



FROM CH 9587.530 TO CH 9605.530 DENSO S43/R23 WRAP SYSTEM  
FROM CH 9354.039 TO CH 9943.927 6.35mm wt  
FROM CH 10052.100 TO CH 10429.259 6.35mm wt  
FROM CH 9943.927 TO CH 10052.100 9.27mm wt

**SPECIFICATION FOR 250 NB  
RELOCATED STEEL PIPELINE-August 2011**

PIPE 273.0 mm OD x 6.35 mm & 9.27mm wt  
API STANDARD 5L GRADE X42

COATING POLYETHYLENE FOR LINE PIPE HBE 95 CERAMAGUARD  
FOR EXPOSED AREAS. CANUSA SLEEVES ON PIPE JOINTS.

FIELD WELDING AS 2885.2 - 2007

TESTING HYDROSTATICALLY TESTED  
MAX 7320 kPa

**SPECIFICATION FOR 250 NB  
RELOCATED STEEL PIPELINE-November 2009  
FROM CH 8650.485 TO CH 9395.543**

PIPE 273.0 mm OD x 6.35 mm wt  
API STANDARD 5L GRADE X42

COATING POLYETHYLENE FOR LINE PIPE HBE 95 CERAMAGUARD  
FOR EXPOSED AREAS. CANUSA SLEEVES ON PIPE JOINTS.

FIELD WELDING AS 2885.2 - 2007

TESTING HYDROSTATICALLY TESTED  
MIN 6488 kPa MAX 7612 kPa

- NOTE:**
- ALL PIPE IS 6.35mm wt UNLESS OTHERWISE STATED
  - MARKER TAPE TO BE LAID 300mm ABOVE PIPELINE
  - CP TEST POINTS, ALL EXISTING CABLES WILL BE CONNECTED TO NEW PIPELINE
  - ALTERED 250mm GAS PIPE TO BE LOCATED IN VIC ROADS ROAD RESERVE AND IN EASEMENTS OVER BARWON WATER AND BORAL LAND.
- H.B. HORIZONTAL BEND  
C.B. COMBINED BEND  
V.O.B. VERTICAL OVER BEND  
V.U.B. VERTICAL UNDER BEND  
5/75 MONTH & YEAR MAIN LAID  
N R.L. NATURAL SURFACE (AT TIME OF MAINLAYING)  
P R.L. TOP OF PIPE  
C R.L. TOP OF CONDUIT  
1984.500 DISTANCE ALONG CENTRELINE OF PIPE  
ELECTROLYSIS TEST POINT  
VALVE  
VALVE IN A PIT  
REDUCER  
CONCRETE SLABBING  
CONDUIT  
BORE  
DENSO S43/R23 WRAP SYSTEM

SCALE OF METRES

REFERENCE DRAWINGS	DRAWING TITLE	DRAWING No.
CONCRETE SLAB INSTALLATION		S91-7-1
LICENSE PLAN 99		T328-1-1
PIPELINE RELOCATION LONGITUDINAL SECTION		T23-24-1
HOT TAP DRAWING		T23-11-22
CP TEST POINT 99/11 LOCATION AT LINE VALVE T023-LV03		T23-9-5
TEST POINT 99/12 LOCATION-HAMS RD		T23-9-3
ANODE BED LOCATION		T23-9-1

REFERENCE DRAWINGS	DRAWING TITLE	DRAWING No.
LINE VALVE T023-LV03		T23-8-11
EASEMENT DRAWINGS		T23-7-12 & 23
EASEMENT DRAWINGS		T23-7-38, 39 & 40
ANODE BED EASEMENT		T23-7-34
ROAD CROSSING HAMS RD		T23-5-9
KEY PLAN		A4-100-2

DATE	REV	GRID	DESCRIPTION	BY	CONTR.
19.02.14	O		CLIENT COMMENTS INCLUDED	HA	EPCM
15.08.13	N		AS-BUILT STAGE 4C	HA	EPCM
19.07.13	M		AS CONSTRUCTED STAGE 4B	HA	EPCM
08.03.13	L		OBJECTIVE-GAS, DRAWING MANAGEMENT SYSTEM GOES LIVE		
20.11.11	K		AS CONSTRUCTED	B.McP.	CONNEQ
30.03.11	J		OFFSET SOUTH OF HAMS RD CHANGED TO 16.1M	B.McP.	CONNEQ
16.03.11	H		250T.P. RELOCATION APPROVED FOR CONSTRUCTION	B.McP.	CONNEQ

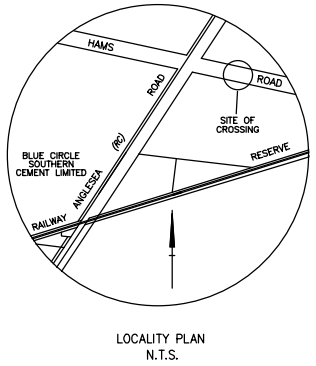
**GEELONG NORTH - WAURN PONDS T/P  
TRANSMISSION PIPELINE, WAURN PONDS**

**GEELONG RING RD, ROUTE PLAN**

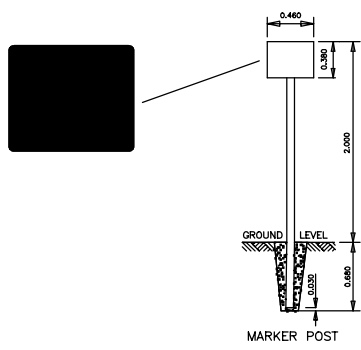
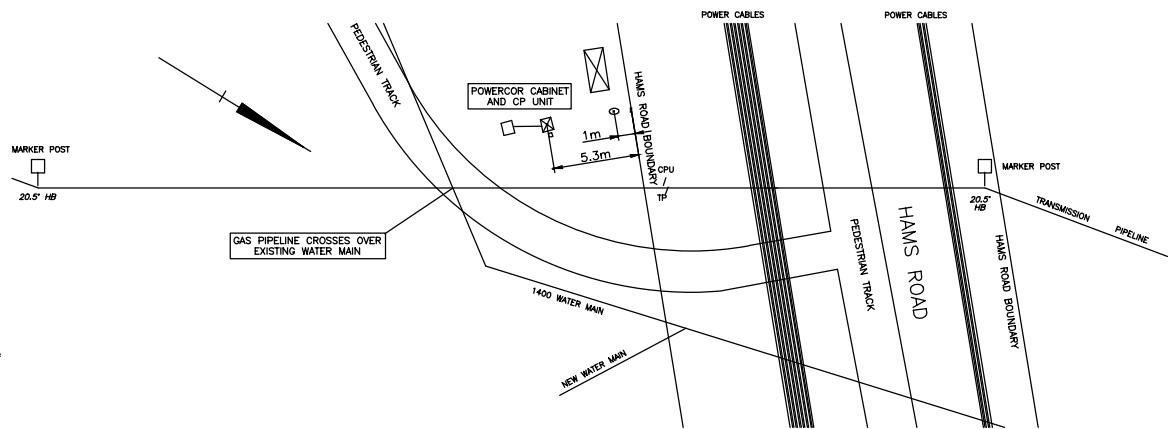
Scale Refer Above  
Mileway 164, H8-18  
District Plan Ref. Corio 10.6,10.7

SP AusNet No. T23-24 0

SP AusNet - Gas STD A1



COMDAIN has taken care to ensure that the location of gas mains and other utility assets shown on this plan are accurate.  
 However, it is acknowledged that some variations to the current information on site may exist and therefore, complete accuracy cannot be guaranteed. It is essential that the location of all assets on site are PROVEN BY HAND EXCAVATION.  
 Where conflicting or unclear information regarding gas assets is encountered, activities on site are to cease immediately and the matter referred to the Engineering Manager for resolution.  
 COMDAIN shall not be liable for any loss, damage, claim or demand incurred either directly or indirectly resulting from any act or omission which has been made in reliance in whole or in part upon this plan.



**GENERAL INFORMATION**  
 OWNER: SP NETWORKS GAS  
 2 SOUTHBANK BOULEVARD, SOUTHBANK, 3006  
 Ph. 9695 6000  
 CONTRACTOR: COMDAIN INFRASTRUCTURE  
 1 WOOD STREET, THOMASTOWN, 3074  
 Ph. (03) 9463 8360  
 DATE OF INSTALLATION: TBA  
 METHOD OF INSTALLATION: OPEN CUT  
 MINIMUM DEPTH OF COVER: 1.20m  
 CONTENTS TO BE HANDLED: NATURAL GAS  
 CATHODIC PROTECTION: YES

**NOTES:**  
 HAMS ROAD HAS BEEN TRUNCATED AT THIS LOCATION AND IS STILL ROAD RESERVE, BUT ONLY CARRIES PEDESTRIAN TRAFFIC BETWEEN TRUNCATED ENDS  
 ALL BACK FILL & COMPACTION TO BE AS PER SP1600 & TS 4060

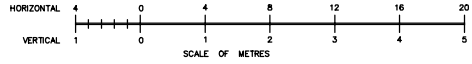
**PIPE SPECIFICATION**  
 CARRIER PIPE  
 INTERNAL DIAMETER: 254.56mm  
 OUTSIDE DIAMETER: 273.10mm  
 PIPE MATERIAL: STEEL  
 SPECIFICATION AND GRADE: API SL X42 ERW  
 WALL THICKNESS: 6.35mm  
 MAXIMUM WORKING PRESSURE: 2800 kPa  
 TYPE OF JOINT: WELDED  
 PIPE COATING: POLYETHYLENE/YELLOW JACKET  
 WELDED JOINT COATING: CANUSA HEAT SHRINK SLEEVE  
 ELECTRICALLY CONTINUOUS: YES  
 FIELD WELDING SPECIFICATION: AS 2885.2 2007  
 TESTING: INSITU HYDROSTATIC TEST TO MIN 6488 kPa, MAX 7612kPa

ITEM	DESCRIPTION	STORES No.	DRG. No.	QTY.
1	250mm TRANSMISSION PIPE			
2	1400mm WATER MAIN			
3	POWER CABLES			
4	PEDESTRIAN TRACK			
5	HAMS ROAD BOUNDARY			
6	MARKER POST			
7	TRANSMISSION PIPELINE			
8	NEW WATER MAIN			
9	POWERCOR CABINET AND CP UNIT			
10	20.5 HB MARKER POST			
11	45° VOB			
12	PIPELINE			

PROGRESSIVE HORIZONTAL DISTANCES	9804.250	9795.495	9785.678	68.309	70.089	68.962	70.195	1.309	9774.640	9774.632	9774.623	9774.615	9774.607	9774.599	9765.000	9755.571	70.162	70.388	72.244	9733.796	9732.807	9746.089	70.259	75.947	62.709	9745.885	68.211	71.476	62.265	9744.847	9743.110	68.094	71.358	62.242	9741.623	70.376	71.509	1.182	9733.790	70.449	71.671	1.201
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DATUM HT. 65.00 (AHD.)



LOCATION	GROVEDALE
FIELD AREA	
FIELD BOOK	
LEVEL DATUM	



ROAD CROSSING  
 250 GAS PIPELINE CROSSING HAMS RD AT ANGLESEA ROAD.  
 HAMS ROAD  
 A. KOUKLAN  
 APPROVED

WAURNA PONDS  
 R. McDUGALL  
 Client Approval/If req'd

SCALE: AS SHOWN  
 MELWAY: 444 - 10  
 DISTRICT PLAN No. COHO 10.06  
 DRAWN: B. McPHERSON  
 CHECKED: C. BALABANIS  
 © SP AusNet

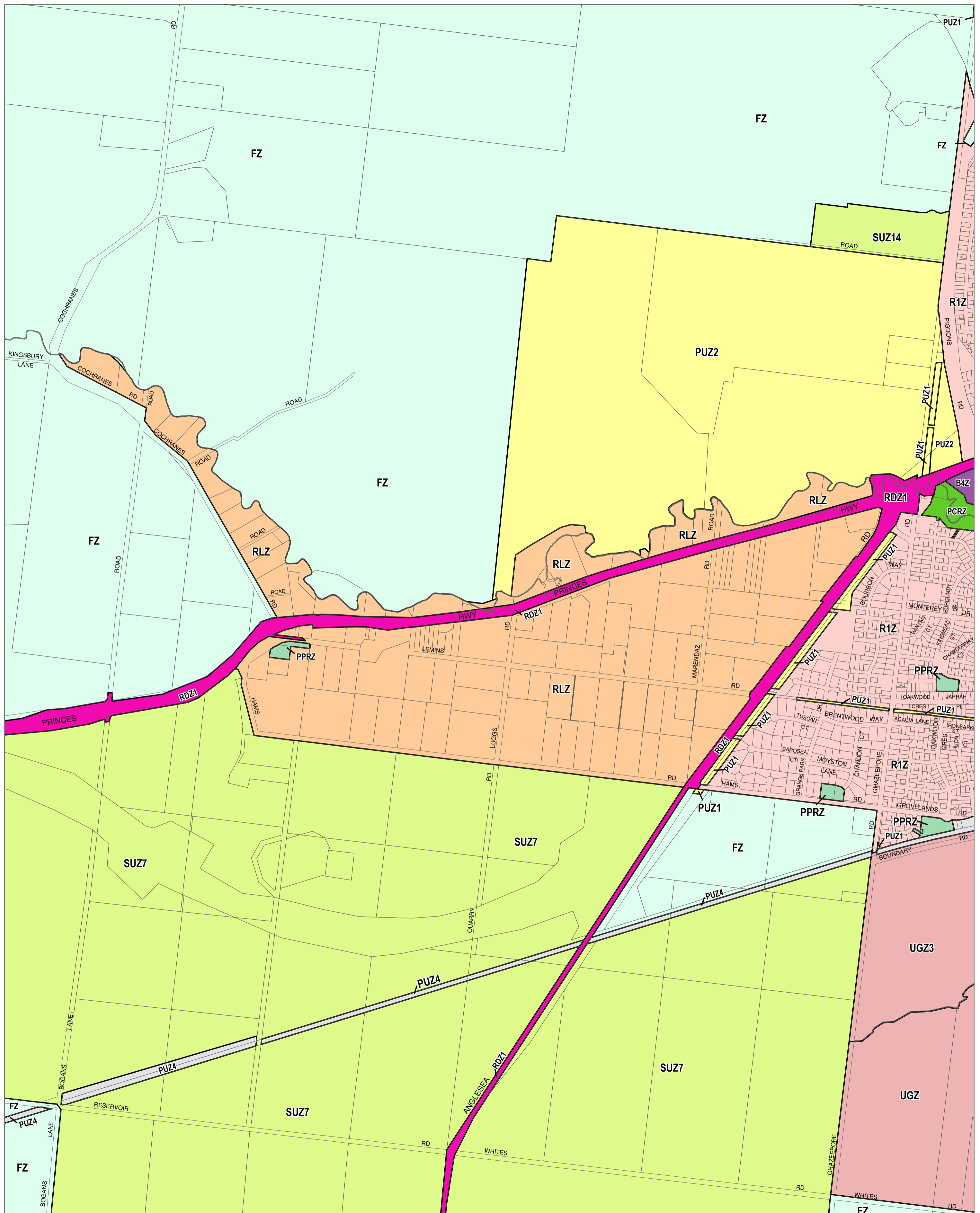
980-8-1  
 980-010-2  
 DRG. NO.

T23-5-9  
 C

NO.	REF.	DATE	REVISION	DRN.	OKD.	APP.
C		8-02-12	AS BUILT	BMCP	KCB	D/G
B		30-03-11	1400 WATER MAIN SOURCE VALVE NOTE & POWERCOR CABINET ADDED	BMCP	KCB	JDR
A		11-03-11	APPROVED FOR CONSTRUCTION	BMCP	KCB	JDR

ROUTE PLAN	T23-24	MARKER POST - HIGH LEVEL	S90-8-1
ANODE BED DRAWING	T23-9-1	SIGNAGE FOR GAS ASSETS	S90-010-2
REFERENCE DRAWINGS	DRG. NO.	REFERENCE DRAWINGS	DRG. NO.

# GREATER GEELONG PLANNING SCHEME - LOCAL PROVISION



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Business	Rural	Special Purpose
B4Z Business 4 Zone	FZ Farming Zone	SUZ14 Special Use Zone - Schedule 14
Public Land	RLZ Rural Living Zone	SUZ7 Special Use Zone - Schedule 7
PCRZ Public Conservation And Resource Zone		UGZ Urban Growth Zone
PPRZ Public Park And Recreation Zone		UGZ3 Urban Growth Zone - Schedule 3
PUZ2 Public Use Zone - Education		
PUZ1 Public Use Zone - Service And Utility		
PUZ4 Public Use Zone - Transport		
RDZ1 Road Zone - Category 1		
Residential		
R1Z Residential 1 Zone		

200 0 200 400 600 800 1000 m

AUSTRALIAN MAP GRID ZONE 55

INDEX TO ADJOINING METRIC SERIES MAP

10	11	12	13	14	15
5	6	7	8		
9	16	17	18	19	20
23	24	25	26	27	28
31	32	33	34	35	36
43	44	45	46	47	48
56	57	58	59	60	61
69	70	71	72	73	74
83	84	85	86	87	88
97	98	99			

Printed: 28/1/2014

AMENDMENT C294



# Appendix D

## Pipeline Calculations for the SMS

# AS2885.1 CALCULATIONS



Project	SMS: SP AusNet Pipeline Near Hams Road
Client	SMEC Urban
Calculations	136100-EL-CAL-001 - AS2885 Buried Pipeline Calculations
Date	3/04/2014
Engineer	K. Culshaw
Suite Sheets	13 (including this sheet)

**MANDATORY REFERENCES:**

- |                             |   |
|-----------------------------|---|
| 1 AS 2885.1 - 2012          | <i>Pipelines-Gas &amp; liquid petroleum   Part 1: Design &amp; construction</i> |
| 2 API 5L 45th edn.          | <i>Specification for Line pipe</i>  |
| 3 API RP 1102 7th edn. Er.2 | <i>Steel Pipelines Crossing Railroads &amp; Highways</i>                        |

**DESIGN BASIS AND REFERENCES:**

- 1 Linepipe data from email A. Stafford to D. Woods, 17th March 2014.
- 2 Location classification T1.
- 3 Gas composition assumed based on typical Victorian sales gas composition.
- 4 Hydraulic modelling assumes no elevation changes.
- 5 Other assumptions and references as noted on global calculation inputs page.

**CONTENTS:**

- Basis of Calculations (this sheet)
- Input data
- Wall thickness for internal pressure
- Uncased road crossing analysis (formal)
- Uncased road crossing analysis (informal)
- Penetration resistance analysis
- Energy discharge (modelled) & radiation contour measurement lengths

**NOTES:**

**SUMMARY:**

The pipeline wall thickness of 6.35 mm exceeds the minimum required wall thickness for pressure containment of 1.62 mm.

The actual design factor of the pipe (hoop stress) is 0.2 and the pipe meets the no rupture criterion of AS2885.1.

The pipeline is suitable for formal road crossings with 1200mm depth of cover and informal crossings with 900mm depth of cover for Australian vehicle loads per AS2885.1 Appendix V.

The pipeline will not be penetrated by excavators up to and including 55 tonnes fitted with general purpose teeth.

The pipeline could be penetrated by excavators 15 tonnes and above fitted with penetration type teeth.

The measurement length (based on 4.7kW/m<sup>2</sup> radiation contour for full bore rupture) is 120m.

The maximum credible hole size is 125mm and the corresponding energy release rate is 2.79 GJ/s.

This largest credible hole size is based on excavator threats only and is based on a largest credible excavator size of 55 tonnes. Maximum excavator size, and therefore maximum credible hole size, may be reduced subsequent to threat survey and Initial SMS.

Revision	By	Date	Checked	Date	Approved	Date
A	K. Culshaw	03-Apr-14	D. Woods	03-Apr-14	M. Wallace	03-Apr-14

## AS2885 Pipe Line Global Calculation Inputs



**Project Title:** SMS: SP AusNet Pipeline Near Hams Road  
**Calc Title:** 136100-EL-CAL-001 - AS2885 Buried Pipeline Calculations  
**Engineer:** K. Culshaw

**Client:** SMEC Urban  
**Date:** 3/04/2014  
**Revision:** A

### Pipeline Material Properties

Nominal diameter:		<i>DN 250</i>	
Outside Pipe Diameter:	D	273.1 mm	
Pipe Grade:		<i>API 5L X42</i>	<i>250NB TRANS P'LINE-AUS.PORTLAND</i>
Pipe Fabrication:		<i>ERW</i>	<i>DRAWING R T23-25</i>
Yield strength:	S <sub>y</sub>	290 MPa	<i>SMYS</i>
Ultimate tensile strength:	S <sub>u</sub>	415 MPa	<i>SMTS</i>
Nominal thickness(es)	t <sub>n</sub>	<i>6.35</i> mm	
Internal Pipe Diameter:	ID	260 mm	
Mill tolerance:	H	0.0% <i>not required for qualified pipe: refer 5.4.7 of AS2885.1</i>	
Corrosion Allowance:	CA	<i>0.00</i> mm	
Calculation thickness:	t	6.35 mm	
Young's Modulus:	E	<i>207,000</i> MPa	
Poisson's Ratio:	ν	<i>0.27</i> ul	
Coeff of Thermal Expansion:	α	<i>1.100E-05</i> m/mK	
Steel density:	ρ <sub>steel</sub>	<i>7860</i> kg/m <sup>3</sup>	
Internal Surface Roughness:		<i>25</i> microns	Assumed typical value
Heat transfer to ground:		<i>10</i> W/m <sup>2</sup> . °C	Assumed typical value

### Design Conditions

Design Pressure:	P <sub>D</sub>	<i>2.76</i> MPa	
MAOP:		<i>2.76</i> MPa	
Nominated (max allowable) Design Factor:	F <sub>D-max</sub>	<i>0.8</i> <i>refer 5.4.3 &amp; 3.2.2(a) of AS2885.1</i>	
Consequence area:		<i>High consequence design [location class(es) T1, I, or HI apply]</i>	
Bucket force multiplier (penetration resistance):	B	<i>1.00</i>	<i>refer AS2885.1 Table M5</i>
Nominal Depth of Cover:	D <sub>c</sub>	<i>1,200</i> mm	
Maximum Depth of Cover:	D <sub>c-max</sub>	<i>3,000</i> mm	
Bore Clearance on Diameter		<i>0</i> mm	
Bored Diameter:		<i>273</i> mm	
Max Design Temp:	T <sub>max</sub>	<i>50</i> °C	<i>Assumed Typical</i>
Min Design Temp:	T <sub>min</sub>	<i>0</i> °C	
Installation Temp:	T <sub>c</sub>	<i>15</i> °C	
Direct axial external forces:	P <sub>f</sub>	<i>0</i> kN	
Pipeline total length:		<i>50.0</i> km	Assumed for full bore rupture release rate flow modelling

### Soil Data

Soil Type (API RP1102):		<i>Medium dense sands and gravels; Stiff clay to very stiff clays and silts</i>	
Soil Density (bulk/wet):	ρ <sub>soil</sub>	<i>2,140.0</i> kg/m <sup>3</sup>	<i>AS4678, well graded sand and gravel</i>
Ambient Soil Temp:		<i>15</i> °C	<i>Assumed soil temp at depth of burial</i>

### Transport Fluid Data

Specific heat ratio:	γ	1.27	
Emitted heat intensity fraction:	τ	1	<i>Assumed to be 1</i>
Fraction of heat radiated:	F	0.25	<i>Assumed to be 0.25</i>

#### Fluid Composition 1

Component Properties				Fractional Mixture Properties		
Compound	Molar Mass (kg/kmol)	HHV (MJ/m <sup>3</sup> )	S.G	Mol %	Molar Mass (kg/kmol)	HHV (MJ/m <sup>3</sup> )
Nitrogen	28.013	0	0.9672	1.0200	0.2857326	0.0000
Carbon Dioxide	44.01	0	1.5195	2.1900	0.9638	0.0000
Methane	16.043	37.696	0.5539	90.8200	14.5703	34.2355
Ethane	30.07	66.035	1.0382	4.9600	1.4915	3.2753
Propane	44.097	93.975	1.5224	0.5000	0.2205	0.4699
i-Butane	58.123	121.428	2.0067	0.1000	0.0581	0.1214
n-Butane	58.123	121.782	2.0067	0.1000	0.0581	0.1218
i-Pentane	72.15	149.336	2.491	0.1000	0.0722	0.1493
n-Pentane	72.15	149.676	2.491	0.1000	0.0722	0.1497
Hexanes	86.177	177.556	2.9753	0.0600	0.0517	0.1065
Heptanes	100.204	205.432	3.4596	0.0200	0.0200	0.0411
Octanes plus	114.231	233.287	3.9439	0.0200	0.0228	0.0467
Oxygen	31.9988	N/A	1.1048	0.0000	0.0000	N/A
Carbon Monoxide	28.01	11.966	0.9671	0.0000	0.0000	0.0000
Hydrogen Sulphide	34.08	23.807	1.1765	0.0000	0.0000	0.0000
Water	18.0153	0	0.622	0.0000	0.0000	0.0000
Helium	4.0026	0	0.1382	0.0000	0.0000	0.0000
Hydrogen	2.0159	12.102	0.0696	0.0000	0.0000	0.0000
Number of Components:			12			
Specific Gravity:	SG		0.618 (calculated)			0.618 (specified for calcs)
Higher Heating Value:	HHV		38.717 MJ/m <sup>3</sup> (calc)			38.717 (specified for calcs)
Wobbe Index:	l <sub>w</sub>		49.267 ul (calc)			51.500 (specified for calcs)

## Buried Pipe Wall Thickness Calculation



**Project Title:** SMS: SP AusNet Pipeline Near Hams Road  
**Calc Title/No.:** 136100-EL-CAL-001  
**Engineer:** K. Culshaw

**Client:** SMEC Urban  
**Date:** 3/04/2014  
**Revision:** A

### CALCULATION OBJECTIVE

To calculate the pipe minimum wall thickness for internal pressure in accordance with AS2885.1.

### CALCULATION METHOD

$$t_p = \frac{P_D D}{2 F_D \sigma_y}$$

where:  $t_p$  = calculated wall thickness (mm) *Eqn: 5.4.3 (AS 2885.1)*  
 $P_D$  = design pressure (MPa)  
 $D$  = outside pipe diameter (mm)  
 $F_D$  = design factor = up to 0.60 - 0.80 for buried main line, or 0.67 for pipe line assemblies  
 $\sigma_y$  = pipe grade Specified Minimum Yield Strength (SMYS) (MPa)

### CALCULATION INPUTS

**General / Buried Main Line:**

Nominal diameter:		<i>DN 250</i>		
Outside pipe diameter:	D	273.1	mm	
Nominated (max allowable) Design factor:	$F_{D-max}$	0.8		refer 5.4.3 & 3.2.2(a) of AS2885.1
Design pressure:	$P_D$	2.76	MPa	
Maximum design temperature:	$T_{max}$	50	°C	
Pipe grade:		<i>API 5L X42</i>		
Pipe fabrication:		<i>ERW</i>		
Yield strength:	$\sigma_y$	290	MPa	
Nominal thickness:	$t_n$	6.35	mm	
Mill tolerance:		0.00%		refer 5.4.7 of AS2885.1
Corrosion allowance:	c	0.00	mm	

### CALCULATION OUTPUTS

**Buried Main Line:**

Minimum design wall thickness:	$t_{p-min}$	1.62	mm	excluding allowances
Minimum nominal thick:	$t_w$	1.62	mm	Condition check: $t_n > t_w$ <span style="border: 1px solid black; padding: 2px;">Pass</span>
Nominated design wall thickness:	$t_p$	6.35	mm	nominal less allowances
Calculated actual design factor:	$F_{D-calc}$	0.20		Condition check: $F_{D-max} > F_D$ <span style="border: 1px solid black; padding: 2px;">Pass</span>
Maximum design pressure:	$P_{D-max}$	10.79	MPa	at nominal design thickness / factor

**Special Construction: Uncased Road Crossing Calculation**  
**Formal Crossing - Heavy Vehicle**



<b>Project Title:</b> SMS: SP AusNet Pipeline Near Hams Road	<b>Client:</b> SMEC Urban
<b>Calc Title / Number:</b> 136100-EL-CAL-001	<b>Date:</b> 3/04/2014
<b>Engineer:</b> K. Culshaw	<b>Revision:</b> A

**CALCULATION OBJECTIVE**

To calculate maximum stress and strain, within the pipeline due to loadings at the design conditions for an **uncased formal road crossing**. Calculation basis is API RP1102 for steel pipeline crossing roads (as nominated by AS2885.1), stress limits basis is AS2885.1 Section 5.7

**CALCULATION METHOD**

AS2885.1 nominates API RP1102 for calculation of stresses at road crossings. Following API RP 1102 Section 4, uncased crossings:

**4.7.2.1 Stresses Due to Earth Load**

API RP1102 eqn (1)

- Where:
- $K_{he}$  = stiffness factor for circumferential earth load stress, function of  $[t_w / D]$  API RP1102 Figure 3
  - $B_e$  = burial factor, function of soil classification and  $[H / B_d]$  API RP1102 Figure 3
  - $E_e$  = earth load excavation factor, function of  $[B_d / D]$  API RP1102 Figure 5
  - $\gamma$  = unit weight of soil (kN/m<sup>3</sup>), calculated from soil density
  - $D$  = pipe outside diameter (mm)
  - $H$  = depth of burial (mm)  $S_{He} = K_{he} B_e E_e \gamma D$
  - $B_d$  = bored diameter (mm)
  - $t_w$  = nominal wall thickness minus vanishing allowances i.e. corrosion, manufacturing (mm)

**4.7.2.1 Stresses Due to Live Loads**

$$w = P / A_p$$

API RP1102 eqn (2)

Applied design surface pressure

- Where:
- $P$  = design single wheel load, or design tandem wheel load (kN), typically 80 kN AS2885.1 Appendix V(C)(i)
  - $A_p$  = contact area for wheel load, taken as 0.1 (m<sup>2</sup>) [= tyre footprint 400 x 250 mm] AS2885.1 Appendix V(C)(i)

**4.7.2.2.4.1 Cyclic Hoop Stresses**

$$\Delta S_{Hh} = [K_{Hh} G_{Hh} R \cdot L \cdot F_i W] \leq S_{FL} \cdot F$$

API RP1102 eqn (5 / 20)

- Where:
- $K_{Hh}$  = highway stiffness factor for cyclic hoop stress, function of soil classification, and  $[t_w / D]$  API RP1102 Figure 14
  - $G_{Hh}$  = highway geometry factor, function of pipe diameter  $D$ , and burial depth  $H$  API RP1102 Figure 15
  - $R$  = highway pavement type factor, function axle type, pipe diameter  $D$ , and depth of burial  $H$  API RP1102 Table 2
  - $L$  = highway axle config. factor, function axle type, pipe diameter  $D$ , and depth of burial  $H$  API RP1102 Table 2
  - $F_i$  = impact factor,  $F_i$ , a function of burial depth  $H$  API RP1102 Figure 7
  - $S_{FL}$  = fatigue endurance limit for longitudinal welds (SMLS/ERW or SAW) API RP1102 Table 3
  - $F$  = design factor for longitudinal welds = 0.72 AS2885.1 Table 5.7.8

**4.7.2.2.4.2 Cyclic Longitudinal Stresses**

$$\Delta S_{Lh} = [K_{Lh} G_{Lh} R \cdot L \cdot F_i W] \leq S_{FG} \cdot F$$

API RP1102 eqn (6 / 17)

- Where:
- $K_{Lh}$  = highway stiffness factor for cyclic long. stress, function soil classification, and  $[t_w / D]$  API RP1102 Figure 16
  - $G_{Lh}$  = highway geometry factor, function of pipe diameter  $D$ , and burial depth  $H$  API RP1102 Figure 17
  - $S_{FG}$  = girth weld fatigue limit = 82,740 (kPa) API RP1102 Table 3
  - $F$  = design factor for girth welds = 0.72 AS2885.1 Table 5.7.8

**4.7.3 Stresses Due to Internal Pressure**

$$S_{Hi} = [p(D - t_w) / 2t_w] \leq SMYS \cdot F$$

API RP1102 eqn (7)

- Where:
- $p$  = design pressure (MPa)
  - $F$  = AS2885.1 wall thickness design factor,  $F_D$  AS2885.1 Table 5.7.8

**4.8.1 Total Effective Stress**

$$S_{eff} = \sqrt{0.5[(S_1 - S_2)^2 + (S_2 - S_3)^2 + (S_3 - S_1)^2]} \leq SMYS \cdot F$$

API RP1102 eqn (12 / 13)

- Where:
- $S_1$  = maximum hoop stress =  $S_{He} + \Delta S_{Hh} + S_{Hi}$  (MPa) API RP1102 eqn (9)
  - $S_2$  = maximum long. stress =  $\Delta S_L - E_S \alpha_T (T_2 - T_1) + v_S (S_{He} + S_{Hi})$  API RP1102 eqn (10)
  - $S_3$  = maximum radial stress =  $-p$  API RP1102 eqn (11)
  - $F$  = crossing design factor, 0.72 for formed road, 0.9 for ROW or unformed road AS2885.1 §5.7.3(c)(i)(A) / Table 5.7.8

**4.8.2 Fatigue**

Ensure cyclic stress amplitudes are less than the fatigue endurance limits as shown by inequalities above

**ASSUMPTIONS & NOTES**

- Minimum depth of cover for formed road crossing 1200mm as required by AS2885.1 Figure 5.8.8(B) note 2.
- Default crossing type assumed is; formed road with no pavement and tandem axle for worst case scenario.
- AS2885.1 V4(c)(i) vehicle loading (AS5100.2 W80 wheel and A160 axle) is assumed as worst case. Tracked vehicles and other vehicles illegal on roads are not considered.
- Using this loading case with API RP1102 impact factors may be quite conservative, and for Australian vehicle loads it is expected that tandem-axle configuration will always be more severe, as noted by AS2885.1 Clause V4.

## CALCULATION INPUTS

<b>Pipeline Material Properties:</b>			<b>General Design Conditions:</b>		
Nominal diameter:		DN 250	Design Pressure:	p	2.76 MPa
Outside diameter:	D	273.1 mm	Maximum Design Factor:	F <sub>D</sub>	0.8
Wall thickness:	t <sub>w</sub>	6.35 mm	Max Design Temp:	T <sub>max</sub>	50 °C
Material:		API 5L X42	Min Design Temp:	T <sub>min</sub>	0 °C
SMYS:		290 MPa	Installation Temp:	T <sub>1</sub>	15 °C
Construction:		ERW	Soil classification:		<i>Medium dense sands and gravels; Stiff clay to very stiff clays and silts</i>
Young's Modulus:	E <sub>s</sub>	207,000 MPa	Modulus of soil reaction:	E'	6.9 MPa
Poisson's Ratio:	ν <sub>s</sub>	0.27	Resilient modulus:	E <sub>r</sub>	69.0 MPa
Coeff of Thermal Exp:	α <sub>T</sub>	1.100E-05 m/mK	Soil density:	ρ <sub>soil</sub>	2,140.0 kg/m <sup>3</sup>
<b>Vehicle Loading Conditions:</b>			<b>Crossing Specific Design Conditions:</b>		
Axle type:		Tandem axle	Crossing type:		Formed Road (Sealed and Unsealed)
Wheel load:	P	80 kN	Crossing design factor:	F	0.72
Equivalent mass:		8.15 tonnes	Pavement type:		No pavement
Contact area:	A <sub>p</sub>	0.1 m <sup>2</sup>	DoC at Crossing:	H	1,200 mm
			Bored diameter:	B <sub>d</sub>	273 mm

## CALCULATION SUMMARY

Relative to stress limits as per AS2885.1 Table 5.7.8; all design stresses are within acceptable limits:

- Stress due to earth loading within acceptable limits
- Cyclic hoop stress due to live loads is within acceptable limits
- Cyclic longitudinal stress due to live loads is within acceptable limits
- Stress due to internal pressure is within acceptable limits
- The Total Effective Stress is within acceptable limits

The calculated maximum design stress is 42% SMYS, and the minimum required thickness is 2.3 mm.

## CALCULATION OUTPUTS

4.7.2.1 Stresses Due to Earth Loading:						% SMYS	Pass/Fail	Limit
Wall thickness to diameter ratio:	t <sub>w</sub> / D	0.023						
Stiffness Factor:	K <sub>he</sub>	1971.94	API RP1102 Figure 3	data range OK				
Depth to bored diameter ratio:	H/B <sub>d</sub>	4.39						
Soil type:		Type B	API RP1102 Figure 4					
Burial Factor:	B <sub>e</sub>	0.93	API RP1102 Figure 4	data range OK				
Bored to pipe diameter ratio:	B <sub>d</sub> / D	1.00						
Excavation Factor:	E <sub>e</sub>	0.83	API RP1102 Figure 5	data range OK				
Soil unit weight:	γ	20.99 kN/m <sup>3</sup>						
Earth loading stress:	S <sub>He</sub>	8.78 MPa	API RP1102 eqn (1)		3.0%	Pass	72.0%	
4.7.2 Stresses Due to Live Loads:								
Applied surface pressure:	w	800.00 kPa	API RP1102 eqn (2)					
Pavement type factor:	R	1.10	API RP1102 Table 2					
Axle type factor:	L	1.00	API RP1102 Table 2					
Impact factor:	F <sub>i</sub>	1.50	API RP1102 Figure 7	data range OK				
Highway stiffness factor - hoop:	K <sub>Hh</sub>	12.99	API RP1102 Figure 14	data range OK				
Highway geometry factor - hoop:	G <sub>Hh</sub>	1.30	API RP1102 Figure 15	data range OK				
Hoop stress fatigue limit:	S <sub>FL</sub>	144.80 MPa	API RP1102 Table 3					
Cyclic hoop stress:	ΔS <sub>Hh</sub>	22.26 MPa	API RP1102 eqn (5)		7.7%	Pass	35.9%	
Highway stiffness factor - long.:	K <sub>Lh</sub>	9.42	API RP1102 Figure 16	data range OK				
Highway geometry factor - long.:	G <sub>Lh</sub>	1.19	API RP1102 Figure 17	data range OK				
Cyclic longitudinal stress:	ΔS <sub>Lh</sub>	14.82 MPa	API RP1102 eqn (6)		5.1%	Pass	20.5%	
Internal pressure stress:	S <sub>Hi</sub>	57.97 MPa	API RP1102 eqn (7)		20.0%	Pass	80.0%	
4.8.1 Total Effective Stress								
Maximum hoop stress:	S <sub>1</sub>	89.01 MPa	API RP1102 eqn (9)					
Longitudinal stress:	S <sub>2</sub>	-46.85 MPa	API RP1102 eqn (10)	Self is maximum for, hence calculated at T2 = Tmax				
Total effective stress:	S <sub>eff</sub>	120.05 MPa	API RP1102 eqn (12)		41.4%	Pass	72.0%	
<b>Minimum required thickness for all Pass:</b>								
					t <sub>w-min</sub>	2.28	mm	

**Special Construction: Uncased Road Crossing Calculation**  
**Informal Crossing - Light Vehicle**



**Project Title:** SMS: SP AusNet Pipeline Near Hams Road  
**Calc Title / Number:** 136100-EL-CAL-001

**Client:** SMEC Urban  
**Date:** 3/04/2014

**Engineer:** K. Culshaw

**Revision:** A

**CALCULATION OBJECTIVE**

To calculate maximum stress and strain, within the pipeline due to loadings at the design conditions for an **uncased informal road crossing**. Calculation basis is API RP1102 for steel pipeline crossing roads (as nominated by AS2885.1), stress limits basis is AS2885.1 Section 5.7

**ASSUMPTIONS & NOTES**

- 1 Minimum depth of cover for formed road crossing 1200mm as required by AS2885.1 Figure 5.8.8(B) note 2 is not applicable for informal (track) crossing.
- 2 Default crossing type assumed is; unformed road with no pavement and tandem axle.
- 3 AS2885.1 V4(c)(i) vehicle loading (AS5100.2 W80 wheel and A160 axle) is assumed as worst case. Tracked vehicles and other vehicles illegal on roads are not considered.

**CALCULATION INPUTS**

Pipeline Material Properties:		General Design Conditions:	
Nominal diameter:	DN 250	Design Pressure:	p 2.76 MPa
Outside diameter:	D 273.1 mm	Maximum Design Factor:	F <sub>D</sub> 0.8
Wall thickness:	t <sub>w</sub> 6.35 mm	Max Design Temp:	T <sub>max</sub> 50 °C
Material:	API 5L X42	Min Design Temp:	T <sub>min</sub> 0 °C
SMYS:	290 MPa	Installation Temp:	T <sub>i</sub> 15 °C
Construction:	ERW	Soil classification:	Medium dense sands and gravels; Stiff clay to very stiff clays and silts
Young's Modulus:	E <sub>s</sub> 207,000 MPa	Modulus of soil reaction:	E' 6.9 MPa
Poisson's Ratio:	ν <sub>s</sub> 0.27	Resilient modulus:	E <sub>r</sub> 69.0 MPa
Coeff of Thermal Exp:	α <sub>T</sub> 1.100E-05 m/mK	Soil density:	ρ <sub>soil</sub> 2,140.0 kg/m <sup>3</sup>
<b>Vehicle Loading Conditions:</b>		<b>Crossing Specific Design Conditions:</b>	
Axle type:	Tandem axle	Crossing type:	Unformed Road (Informal Crossing)
Wheel load:	P 80 kN	Crossing design factor:	F 0.9
Equivalent mass:	8.15 tonnes	Pavement type:	No pavement
Contact area:	A <sub>p</sub> 0.1 m <sup>2</sup>	DoC at Crossing:	H 900 mm
		Bored diameter:	B <sub>d</sub> 273 mm

**CALCULATION SUMMARY**

Relative to stress limits as per AS2885.1 Table 5.7.8; all design stresses are within acceptable limits:  
**Stress due to earth loading within acceptable limits**  
**Cyclic hoop stress due to live loads is within acceptable limits**  
**Cyclic longitudinal stress due to live loads is within acceptable limits**  
**Stress due to internal pressure is within acceptable limits**  
**The Total Effective Stress is within acceptable limits**  
**The calculated maximum design stress is 42% SMYS, and the minimum required thickness is 1.7 mm.**

**CALCULATION OUTPUTS**

4.7.2.1 Stresses Due to Earth Loading:				% SMYS	Pass/Fail	Limit
Wall thickness to diameter ratio:	t <sub>w</sub> / D	0.023				
Stiffness Factor:	K <sub>he</sub>	1971.94	API RP1102 Figure 3			data range OK
Depth to bored diameter ratio:	H/B <sub>d</sub>	3.30				
Soil type:		Type B	API RP1102 Figure 4			
Burial Factor:	B <sub>e</sub>	0.81	API RP1102 Figure 4			data range OK
Bored to pipe diameter ratio:	B <sub>d</sub> / D	1.00				
Excavation Factor:	E <sub>e</sub>	0.83	API RP1102 Figure 5			data range OK
Soil unit weight:	γ	20.99 kN/m <sup>3</sup>				
Earth loading stress:	S <sub>He</sub>	7.63 MPa	API RP1102 eqn (1)	2.6%	Pass	72.0%
<b>4.7.2 Stresses Due to Live Loads:</b>						
Applied surface pressure:	w	800.00 kPa	API RP1102 eqn (2)			
Pavement type factor:	R	1.10	API RP1102 Table 2			
Axle type factor:	L	1.00	API RP1102 Table 2			
Impact factor:	F <sub>i</sub>	1.50	API RP1102 Figure 7			data range OK
Highway stiffness factor - hoop:	K <sub>Hh</sub>	12.99	API RP1102 Figure 14			data range OK
Highway geometry factor - hoop:	G <sub>Hh</sub>	1.30	API RP1102 Figure 15			data range OK
Hoop stress fatigue limit:	S <sub>FL</sub>	144.80 MPa	API RP1102 Table 3			
Cyclic hoop stress:	ΔS <sub>Hh</sub>	22.26 MPa	API RP1102 eqn (5)	7.7%	Pass	35.9%
Highway stiffness factor - long.:	K <sub>Lh</sub>	9.42	API RP1102 Figure 16			data range OK
Highway geometry factor - long.:	G <sub>Lh</sub>	1.19	API RP1102 Figure 17			data range OK
Cyclic longitudinal stress:	ΔS <sub>Lh</sub>	14.82 MPa	API RP1102 eqn (6)	5.1%	Pass	20.5%
Internal pressure stress:	S <sub>Hi</sub>	57.97 MPa	API RP1102 eqn (7)	20.0%	Pass	80.0%
<b>4.8.1 Total Effective Stress</b>						
Maximum hoop stress:	S <sub>i</sub>	87.86 MPa	API RP1102 eqn (9)			
Longitudinal stress:	S <sub>2</sub>	-47.16 MPa	API RP1102 eqn (10)			Self is maximum for, hence calculated at T2 = Tmax
Total effective stress:	S <sub>eff</sub>	119.20 MPa	API RP1102 eqn (12)	41.1%	Pass	90.0%
<b>Minimum required thickness for all Pass:</b>				t <sub>w-min</sub>	1.62	mm

## Penetration Resistance & Failure Mode Calculation



<b>Project Title:</b> SMS: SP AusNet Pipeline Near Hams Road	<b>Client:</b> SMEC Urban	
<b>Calc Title: / No.</b> 136100-EL-CAL-001	<b>Date:</b> 3/04/2014	
<b>Engineer:</b> K. Culshaw	<b>Revision:</b> A	

### CALCULATION OBJECTIVE

To calculate the smallest excavator threat capable of causing leak and rupture failure.

### CALCULATION METHOD

Following AS2885.1 Appendix M

The force required to penetrate the pipe is given by equation M3:

$$R_p = 0.007t_w(\sigma_u + 410)(L + 22.4)\left(\frac{W}{W + 3.14}\right)$$

Where:  $t_w$  = nominal thickness - vanishing allowances (mm)  
 $\sigma_u$  = Ultimate tensile strength SMTS (MPa)  
 $L$  = excavator tooth length (mm) refer Table M3  
 $W$  = excavator tooth width (mm)

Except that  $R_p$  for TPTT = 1.75 x  $R_p$  for SPTT as per AS2885.1 Appendix M3

The maximum force delivered by an excavator has been reasonably correlated against its mass, as per equation M4:

$$F_{Bucket} = 7.5W_{OP} - 0.04(W_{OP})^2$$

Where:  $W_{OP}$  = excavator mass (tonnes) refer Table M3

Penetration should not occur if the following condition is met, as per equation M2:

$$R_p > B \times F$$

Where:  $B$  = bucket force multiplier factor of safety, derived by empirical experience, selected from Table M5. Typically 0.75 to 1.3.

Where penetration does occur, the failure mode may be:

- a) rupture; where maximum hole length is greater than or equal to the CDL refer Clause 4.11.3(ii)
- b) leak; where maximum hole length is less than the CDL
- c) no penetration; dent or gouge only (this condition inherently satisfies 'no rupture' requirements)

The teeth most commonly found on excavators are Twin Pointed Tiger Teeth (TPTT) and General Purpose Teeth (GPT).

Single Point Penetration Teeth (SPPT) are usually restricted to machines used specifically for hard ground conditions.

It is up to the Safety Management Study to determine the credibility of any particular threat (tooth or excavator size).

*Note: although rupture may not be a credible failure mode, additional criteria are required to satisfy 'no rupture' design for area classes T1/I/S (and sometimes HI); either hoop stress shall not exceed 30% SMYS (refer CDL calculation), OR the largest equivalent defect axial length shall not exceed 150% of CDL.*

### CALCULATION INPUT DATA

Mat'l	<b>API 5L X42</b>	Specified material grade
Nom. D	<b>DN 250</b>	Nominal diameter
D	<b>273.1 mm</b>	Outside Diameter
$t_w$	<b>6.35 mm</b>	Specified wall thickness less vanishing allowances (calculation thickness)
$\sigma_u$	<b>415.0 MPa</b>	Specified Minimum Tensile Strength (SMTS)

Design case:

**High consequence design [location class(es) T1, I, or HI apply]**

Design for 'No Rupture'

**B**      **1.00** ul      Bucket force multiplier, factor of safety refer AS2885.1 Table M5

*Note on B Factor Selection:*

*In AS2885.1 a value of B= 1.0 is recommended "Where penetration resistance can be reasonably relied on to satisfy the requirements of the safety management study for 'no puncture'". A value of 1.3 or greater is only needed "Where penetration must never occur, such as may sometimes be necessary to meet the special requirements for high consequence areas (e.g. where the release rate from a hole would exceed the permitted value, or where the size of a hole would exceed the critical defect length)".*

**M**      **55** tonne      Maximum credible excavator threat Assumed 55T unless specified otherwise by Design Basis or SMS

Inputs from Critical defect length calculations:

P	<b>2.76</b> MPa	MAOP Internal Pressure	<i>for reference only, not used directly in Penetration calculations</i>
CDL	mm	Critical Defect Length	<i>Critical defect length calculation not applicable; hoop stress &lt;30% SMYS.</i>
$\sigma_H$	<b>20.5%</b>	Hoop stress % of SMYS at MAOP	

## CALCULATION SUMMARY

For excavators up to 55T the pipeline is NOT 'no puncture' having credible hole diameters of 20 to 125 mm.

As the pipeline actual design factor for hoop stress is less than 0.3, all of these hole sizes will result in a leak but not a rupture.

*The smallest excavator to penetrate and probable consequence:*

Excavator Tooth Type		Machine Size to cause Leak and Rupture			
Description		Leak / Puncture		Allowable excavator threat to meet 'no rupture' condition	Rupture
		Machine Size	Max Hole Ø (mm)		
General Purpose Tooth	GPT	>55T	N/A	>55T	>55T
Twin Points of Tiger Tooth	TPTT	35T	125	>55T	>55T
Single Point of Tiger Tooth	SPTT	15T	35	>55T	>55T
Single Point Penetration Tooth	SPPT	15T	90	>55T	>55T

## PENETRATION & FAILURE MODE CALCULATION

W <sub>OP</sub>	Tooth Type	L (at tip)	W (at tip)	Max Tooth / hole Length	Hole Dia (50% tooth length penetration)	t <sub>w</sub>	R <sub>p</sub>	F <sub>bucket</sub>	BF	R <sub>p</sub> > BF	Penetrate?	CDL	FAILURE	CDL / max credible hole Length	
(T)		(mm)	(mm)	(mm)	(mm)	(mm)	(MPa)	(KN)	(KN)	(KN)					
5	GPT	51	4	70	55	6.35	415.00	150.79	36.50	36.50	Yes	No	N/A	Dent/Gouge	N/A
5	TPTT	6	5	70	55	6.35	415.00	111.95	36.50	36.50	Yes	No	N/A	Dent/Gouge	N/A
5	SPTT	6	5	70	15	6.35	415.00	63.97	36.50	36.50	Yes	No	N/A	Dent/Gouge	N/A
5	SPPT	6	5	70	40	6.35	415.00	63.97	36.50	36.50	Yes	No	N/A	Dent/Gouge	N/A
10	GPT	56	14	70	60	6.35	415.00	234.83	71.00	71.00	Yes	No	N/A	Dent/Gouge	N/A
10	TPTT	8	7	70	60	6.35	415.00	134.68	71.00	71.00	Yes	No	N/A	Dent/Gouge	N/A
10	SPTT	8	7	70	20	6.35	415.00	76.96	71.00	71.00	Yes	No	N/A	Dent/Gouge	N/A
10	SPPT	8	7	70	45	6.35	415.00	76.96	71.00	71.00	Yes	No	N/A	Dent/Gouge	N/A
15	GPT	63	13	85	65	6.35	415.00	252.25	103.50	103.50	Yes	No	N/A	Dent/Gouge	N/A
15	TPTT	11	9	85	70	6.35	415.00	158.90	103.50	103.50	Yes	No	N/A	Dent/Gouge	N/A
15	SPTT	11	9	85	20	6.35	415.00	90.80	103.50	103.50	No	YES	N/A	LEAK	N/A
15	SPPT	11	9	85	55	6.35	415.00	90.80	103.50	103.50	No	YES	N/A	LEAK	N/A
20	GPT	76	13	95	75	6.35	415.00	290.64	134.00	134.00	Yes	No	N/A	Dent/Gouge	N/A
20	TPTT	13	10	95	80	6.35	415.00	172.89	134.00	134.00	Yes	No	N/A	Dent/Gouge	N/A
20	SPTT	13	10	95	25	6.35	415.00	98.79	134.00	134.00	No	YES	N/A	LEAK	N/A
20	SPPT	13	10	95	60	6.35	415.00	98.79	134.00	134.00	No	YES	N/A	LEAK	N/A
25	GPT	89	18	100	85	6.35	415.00	347.84	162.50	162.50	Yes	No	N/A	Dent/Gouge	N/A
25	TPTT	11	17	100	85	6.35	415.00	180.93	162.50	162.50	Yes	No	N/A	Dent/Gouge	N/A
25	SPTT	11	17	100	25	6.35	415.00	103.39	162.50	162.50	No	YES	N/A	LEAK	N/A
25	SPPT	11	17	100	65	6.35	415.00	103.39	162.50	162.50	No	YES	N/A	LEAK	N/A
30	GPT	102	21	110	95	6.35	415.00	396.85	189.00	189.00	Yes	No	N/A	Dent/Gouge	N/A
30	TPTT	12	20	110	95	6.35	415.00	190.80	189.00	189.00	Yes	No	N/A	Dent/Gouge	N/A
30	SPTT	12	20	110	30	6.35	415.00	109.03	189.00	189.00	No	YES	N/A	LEAK	N/A
30	SPPT	12	20	110	70	6.35	415.00	109.03	189.00	189.00	No	YES	N/A	LEAK	N/A
35	GPT	121	23	125	110	6.35	415.00	462.70	213.50	213.50	Yes	No	N/A	Dent/Gouge	N/A
35	TPTT	14	22	125	110	6.35	415.00	204.42	213.50	213.50	No	YES	N/A	LEAK	N/A
35	SPTT	14	22	125	30	6.35	415.00	116.81	213.50	213.50	No	YES	N/A	LEAK	N/A
35	SPPT	14	22	125	80	6.35	415.00	116.81	213.50	213.50	No	YES	N/A	LEAK	N/A
40	GPT	127	24	135	115	6.35	415.00	484.48	236.00	236.00	Yes	No	N/A	Dent/Gouge	N/A
40	TPTT	16	25	135	120	6.35	415.00	218.93	236.00	236.00	No	YES	N/A	LEAK	N/A
40	SPTT	16	25	135	35	6.35	415.00	125.10	236.00	236.00	No	YES	N/A	LEAK	N/A
40	SPPT	16	25	135	90	6.35	415.00	125.10	236.00	236.00	No	YES	N/A	LEAK	N/A
55	GPT	143	30	145	125	6.35	415.00	549.07	291.50	291.50	Yes	No	N/A	Dent/Gouge	N/A
55	TPTT	17	25	145	125	6.35	415.00	224.63	291.50	291.50	No	YES	N/A	LEAK	N/A
55	SPTT	17	25	145	35	6.35	415.00	128.36	291.50	291.50	No	YES	N/A	LEAK	N/A
55	SPPT	17	25	145	90	6.35	415.00	128.36	291.50	291.50	No	YES	N/A	LEAK	N/A

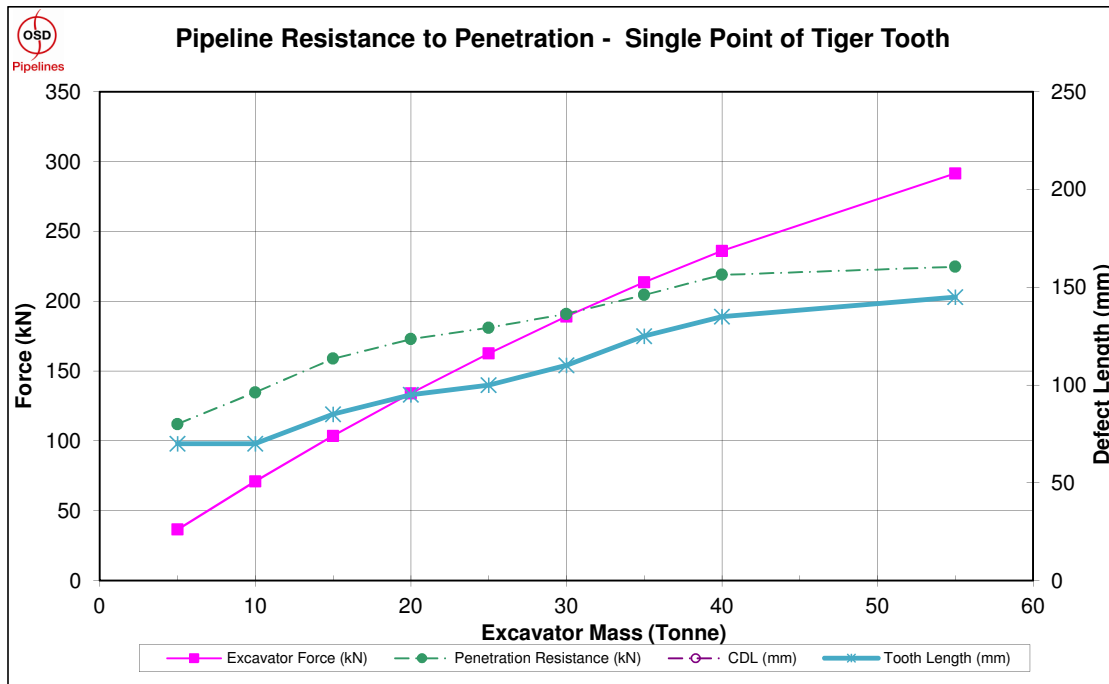
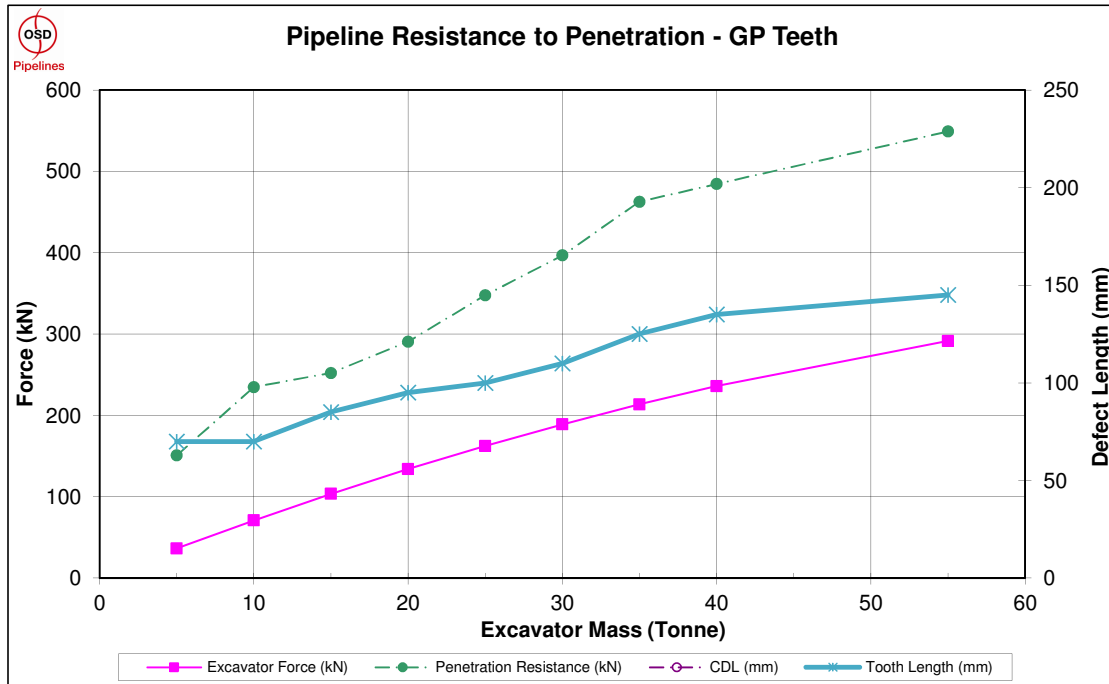
**NOTE 1: EXCAVATOR TOOTH DIMENSIONS**

GPT General Purpose Tooth	TPTT Twin Point of Tiger Tooth
SPPT Single Point Penetration Tooth	L Length of tooth at tip
SPTT Single Point of Tiger Tooth	W Width of tooth at tip

Max tooth length represents defect for 100% of tooth length penetration i.e at base of tooth. Hole diameters for 50% of tooth length penetration are provided for reference in credibility of energy discharge calculations only

## PENETRATION CHARTS

Where excavator force exceeds penetration resistance, leak will occur, or rupture will occur if the tooth size also exceeds the critical defect length.



## Energy Discharge Rates Calculation



<b>Project Title:</b>	SMS: SP AusNet Pipeline Near Hams Road	<b>Client:</b>	SMEC Urban
<b>Calc Title / Number:</b>	136100-EL-CAL-001	<b>Date:</b>	3/04/2014
<b>Engineer:</b>	K. Culshaw	<b>Revision:</b>	A

### CALCULATION OBJECTIVE

To determine the energy discharge rate and radiation contour lines (12.6 and 4.7 kW/m<sup>2</sup>) from an ignited pipeline rupture or leak.

### CALCULATION METHOD

Using Method Specified in AS2885., ie. API 521 (Equation 24, Section 6.4.2.3.3)

$$D = \sqrt{\frac{\tau F Q}{4\pi K}}$$

where:

- D = Radiation Contour Radius (m)
- $\tau$  = Fraction of heat intensity emitted (assumed to be 1)
- F = Fraction of heat radiated (assumed to be 0.25)
- Q = Energy Release Rate (kW), determined by transient modelling in FlowTran software
- K = Energy contour required (4.7 kW/m<sup>2</sup> or 12.6 kW/m<sup>2</sup>)

AS2885.1 Appendix Y for steady state puncture leak modelling:

$R_{12.6 \text{ kW/m}^2} (m) = 1.25 \sqrt{Q}$
$R_{4.7 \text{ kW/m}^2} (m) = 2.10 \sqrt{Q}$

where:

$Q = E * 10^9 / (24 * 3600) (kW)$
-----------------------------------

$E = LHV / \rho * M / 1000$
-----------------------------

- E = Energy Release Rate (TJ/day)
- M = Mass flow (Tonnes/day) =  $1.1 \times 10^{-3} P * A$
- LHV = Lower Heating Value of Gas (MJ/m<sup>3</sup>) where:  $A = \pi \varnothing^2 / 4$
- $\rho$  = Density of gas at STP = SG x density of air where:  $\varnothing$  = hole dia (mm)
- (density of air taken as 1.225 kg/m<sup>3</sup> at STP)

Maximum energy release rates (for credible failure modes) as per AS2885.1 4.7.3:

- 1 GJ/s in High Density (T2) or Sensitive (S) location classes (highest consequence design)
- 10 GJ/s in Residential (T1) or Industrial (I) location classes (high consequence design)

Where hole size is less than 25% of the pipe diameter, steady state equations are utilised for determination of release rate. For full bore rupture and leaks from hole sizes greater than 25% of pipe diameter, transient modelling with Flowtran is utilised to determine the release rate.

### INPUTS

Design case: *High consequence design [location class(es) T1, I, or HI apply]*

Q <sub>max</sub> :	10 GJ/s	Maximum energy release rate for design case
Pressure:	2.76 MPa	Maximum Allowable Operating Pressure
Diameter:	260.4 mm	Internal Diameter
K:	4.70 kW/m <sup>2</sup>	Energy contour threshold of injury
K:	12.60 kW/m <sup>2</sup>	Energy contour threshold of fatality
SG:	0.62	Specific Gravity of Transport fluid
LHV:	34.98 MJ/m <sup>3</sup>	Lower Heating Value of Transport fluid
$\tau$ :	1.00	Emitted heat intensity fraction (assumed)
F:	0.25	Fraction of heat radiated (assumed)

### ASSUMPTIONS & NOTES

Rupture release rates calculated using Flowtran transient modelling using typical assumed values\*. Sensitivity of results to these values is typically very low.

Release rate used at 30 seconds after rupture, and for LHV.

Rupture is not a credible failure mode - refer Penetration Resistance Calculations.

## TRANSIENT MODEL INPUTS

Gas Composition	
Compound	Mol %
Nitrogen	1.0200
Carbon Dioxide	2.1900
Methane	90.8200
Ethane	4.9600
Propane	0.5000
i-Butane	0.1000
n-Butane	0.1000
i-Pentane	0.1000
n-Pentane	0.1000
Hexanes	0.0600
Heptanes	0.0200
Octane plus	0.0200

Pipeline Data	
Length (Total)*	50.0 km
MAOP	2.76 MPa
Internal Diameter	260.4 mm
Internal Surface Roughness*	25 microns
Heat Transfer to Ground Coeff.*	10 W/m <sup>2</sup> .°C
Soil/Ambient Temperature	15 °C

*\*Refer assumptions*

## CALCULATION SUMMARY

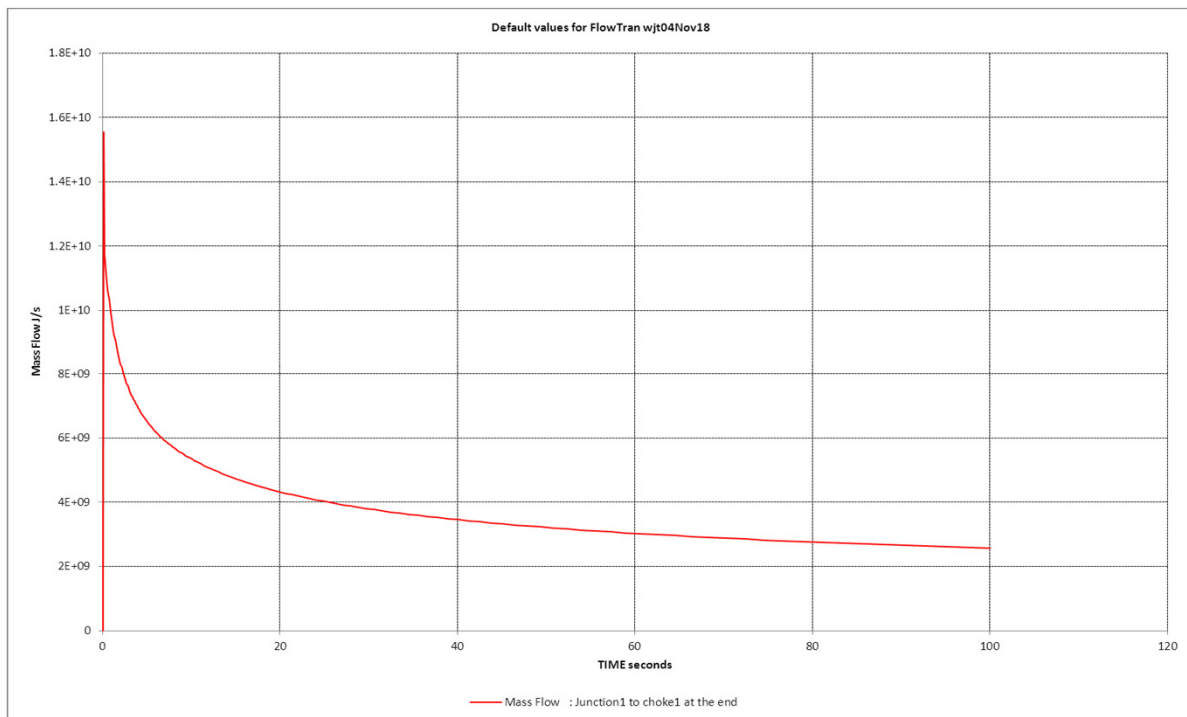
The measurement length for AS2885.1 location class determination is 120m.  
 The maximum credible equivalent hole size is 125mm and the corresponding energy release rate is 2.79GJ/s which complies with the AS2885.1 limit of 10 GJ/s for a T1 location classification. The 4.7 kW/m<sup>2</sup> contour distance for this hole size is 111m.  
 This largest credible hole size is based on excavator threats only and is based on a largest credible excavator size of 55 tonnes.  
 Maximum excavator size, and therefore maximum credible hole size, may be reduced subsequent to threat survey and Initial SMS.

## FULL BORE (MID-LINE) RUPTURE RESULTS

Q: **3,429,598** kW Energy discharge 30s after rupture (output from Flowtran)

The energy discharge rate is:	<b>3.4</b>	GW (GJ/s)	at 30s after rupture	
4.7 kW/m <sup>2</sup> energy contour:	<b>120</b>	m	Eqn (1)	Threshold for injury
12.6 kW/m <sup>2</sup> energy contour:	<b>74</b>	m	Eqn (1)	Threshold for fatality
Acceptance:	<b>Pass</b>			

## FULL BORE (MID-LINE) RUPTURE TRANSIENT MODELLING



## HOLE / LEAK PUNCTURE STEADY STATE FLOW

Hole Size (mm)	Percent of Pipe Dia.	Tooth Type	Credible Penetration Failure?	Flow Rate		R <sub>12.6 kW/m<sup>2</sup></sub> (m)	R <sub>4.7 kW/m<sup>2</sup></sub> (m)	Acceptance
				(GJ/s)	(TJ/d)			
15	6%	N/A	NO					Pass (N/A)
25	10%	SPTT	YES	0.07	6.0	10.4	17.4	Pass
30	12%	SPTT	YES	0.10	8.6	12.5	20.9	Pass
35	13%	SPTT	YES	0.14	11.7	14.5	24.4	Pass
40	15%	N/A	NO					Pass (N/A)
45	17%	N/A	NO					Pass (N/A)
55	21%	SPPT	TBC	0.33	28.8	22.8	38.4	Pass
60	23%	SPPT	TBC	0.40	34.3	24.9	41.8	Pass
65	25%	SPPT	TBC	0.47	40.2	27.0	45.3	Pass
75	29%	N/A	NO					Pass (N/A)
85	33%	N/A	NO					Pass (N/A)
90	35%	SPPT	TBC	2.08	179.9	57.0	95.8	Pass
95	36%	N/A	NO					Pass (N/A)
100	38%	N/A	NO					Pass (N/A)
110	42%	TPTT	YES	2.53	218.8	62.9	105.7	Pass
120	46%	TPTT	YES	2.72	235.2	65.2	109.6	Pass
125	48%	TPTT	YES	2.79	241.4	66.1	111.0	Pass

The hole size range is referenced from AS2885.1 table M3 - credibility is referenced from Penetration Resistance Calculations  
Equations from AS2885.1 Appendix Y were used for steady state leak flow rates and radiation contours



# Appendix E

## SMS Threats Questionnaire



**Hams Road Initial SMS  
AS 2885 Safety Management Study  
Threat Identification Questionnaire**

**Hams Road Initial SMS  
AS2885.1 THREAT IDENTIFICATION QUESTIONNAIRE**

1. PLEASE COMPLETE ELECTRONICALLY OR BY LEGIBLY BY HAND.
2. PLEASE ATTACH ADDITIONAL DETAILS WHERE APPROPRIATE
3. PLEASE ADVISE IF DESIGNER SHOULD CONTACT RESPONDENT FOR ADDITIONAL DETAIL
4. THREATS INCLUDE ENVIRONMENTAL THREATS TO & FROM PIPELINES

<b>RESPONDENT DETAILS</b>	
Organisation:	smec urban on b/h of.
Address:	Level 10/71 Queens Rd Melbourne.
Contact Name:	Randah Jordan. 0411699551.
Contact E-mail	randah.jordan@smec.com.
Designer Contact Required	Douglas Woods 0433952162.

**GENERAL**

The purpose of this questionnaire is to identify all existing and known threats to the integrity of the pipeline that occur as a result of the development works including access in the vicinity of the pipeline either above or below ground.

Its purpose is also intended to identify changes to the land use through which the pipeline is constructed. This may occur as a result of rezoning (Land Planning), or as the result of development, expansion, maintenance of structures along the route, and to land use (changes in farming practices, irrigation, drainage etc.)

Threats identified in this process are required by the design Standard (AS 2885.1) to be considered and mitigated by external interferences and design measures as part of the design process, such that all identified threats to the pipeline integrity are reduced at the time of design to LOW or NEGLIGIBLE.

It is critically important that the Threat Investigation is undertaken diligently, and the identified threats are documented in sufficient detail for the pipeline designer to appreciate them, and to design for them.

The following text from the AS 2885 provides guidance on the threat identification requirements.



### **2.3.2 Threats**

#### **2.3.2.1 General**

The underlying principle of threat identification is that a threat exists at a location.

Threats exist—

- (a) at a specific location (e.g. excavation threat at a particular road crossing);
- (b) at specific sections of a pipeline (e.g. farming; forestry; fault currents for sections with parallel power lines); or
- (c) over the entire length of the pipeline (e.g. corrosion).

The same safety management process applies to both location-specific and non-location specific threats.

NOTE: Non-location-specific threats are often qualitatively different to location-specific threats (e.g. corrosion, versus external interference threats at a road crossing).

#### **2.3.2.2 Location analysis**

The pipeline route shall be analysed to divide it into safety management sections where the land use and population density are consistent.

A safety management section shall not contain more than one location class.

NOTE: Use of safety management sections facilitates the analysis of threats that apply over whole sections of the route (e.g. farming, forestry, urban development, etc.).

#### **2.3.2.3 Threat identification**

Threat identification shall be undertaken for the full length of the pipeline, including stations and pipeline facilities. The threats to be considered shall include, at least—

- (a) external interference,
- (b) corrosion,
- (c) natural events,
- (d) electrical effects,
- (e) operations and maintenance activities,
- (f) construction defects,
- (g) design defects,
- (h) material defects,
- (i) intentional damage, and
- (j) other threats such as seismic and blasting.

NOTE: Guidance on threats is given in Appendix C.



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The threat identification shall consider all threats with the potential to damage the pipeline, cause of interruption to service, cause of release of fluid from the pipeline, or cause harm to pipeline operators, the public or the environment.

NOTE: Typical data sources used to conduct the threat identification include alignment survey data to determine basic geographical information; land user surveys in which land liaison officers gather information from land users on the specific activities carried out on the land, and obtain any other local knowledge; third-party spatial information (GIS type data) on earthquakes, drainage, water tables, soil stability, near-surface geology, environmental constraints, etc., and land planning information.

The threat identification shall generate sufficient information about each threat to allow external interference protection and engineering design to take place. For each identified threat, at least the following information shall be recorded:

- (i) What is the threat to the pipeline?
- (ii) Where does it occur? (the location of the threat)
- (iii) Who (or what) is responsible for the activity?
- (iv) What is done? (e.g. depth of excavation)
- (v) When is it done? (e.g. frequency of the activity, time of the year)
- (vi) What equipment is used? (if applicable, e.g. power of plant, characteristics of the excavator teeth, etc.).



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<b>LAND PLANNING AND DEVELOPMENT</b>	
1)	Are you aware of any development plans (future construction plans and procedures) for any buried services (e.g. Electric, water, drainage, sewerage, gas, telephone or fibre optic installation, or other) along the pipeline route? Please describe what and where: <i>No. All development @ a future stage contained to title boundary.</i>
2)	What threats, other than impact by construction and maintenance activities and associated external loads, do any of these buried services present to the pipeline? (corrosion, heat, ....) Please describe what and where. <i>N/A.</i>
3)	Are there any future developments (e.g. future urban development and subdivisions, rezoning, roads, other infrastructure) planned that may impact upon the pipeline? Please describe what and where: <i>Yes. Land within proximity is proposed for residential rezoning.</i>
4)	Are there any planned redevelopment of adjacent infrastructure (road, rail realignment, power transmission installation etc.) Please describe what and where: <i>Not applicable.</i>
5)	Is the land along the pipeline route subject to flooding? Please describe and provide any relevant flood maps. <i>N/A.</i>
6)	Is the land along the pipeline route involved in, or earmarked for, any irrigation or drainage plans? Please describe what and where: <i>No.</i>
7)	Is the land along the pipeline route subject to any instability such as mine subsidence, or landslides? Please describe what and where: <i>No.</i>
8)	Please describe any other activity your organisation may be involved with that could impact upon the pipeline. A list of possible impacts on the pipeline is attached. <i>No.</i>
10)	Other Comments <i>No.</i>



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<b>MAINTENANCE ACTIVITIES</b>	
1)	Any routine ground disturbance above or around the pipeline, e.g. clearing drains, erecting fences, reinstatement of buried services, road maintenance. <i>apart from fences along western boundary. NO (?)</i>
2)	What sort of maintenance activities does your organisation engage in the area of land along the pipeline route? How often are these activities performed? <i>N/A.</i>
3)	What is the <u>typical</u> and <u>maximum</u> depth of any ground disturbance that may be caused as a result of these activities? How frequently is the ground disturbed to this <i>maximum</i> depth? <i>N/A.</i>
3)	What earth moving and excavation machinery is generally used (type and size)? <i>N/A.</i>
4)	What is the maximum machine weight? How frequently is this machine used in the land around the pipeline? <i>N/A.</i>
5)	What approvals / notifications are required (internally and externally) before maintenance work commences? <i>N/A.</i>
6)	Please give any other pertinent details about your organisation's maintenance activities in the area of land along the pipeline route and describe how they could impact upon the pipeline. <i>N/A.</i>
7)	Other comments <i>N/A.</i>



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CONSTRUCTION ACTIVITIES	
1)	Is your organisation planning on any major upgrades or proposed new works in the vicinity of the pipeline? NO .
2)	Please list these works and where they are intended to be located. N/A
3)	What construction methods will be used? N/A
4)	When is it estimated that these works will commence? N/A .
5)	What is the maximum depth of ground disturbance within the pipeline easement? What height of fill will be placed? N/A .
6)	What type and size of earth moving or excavation machinery will be used? N/A .
7)	What is the maximum machine weight? N/A .
8)	What approvals / notifications are required before work commences? N/A .
9)	Please give any other pertinent details about the construction activities and describe how they could impact upon the pipeline. N/A .
10)	Other Comments



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<b>ADMINISTRATION PROCEDURES FOR LAND MANAGEMENT</b>	
1)	What are your procedures for undertaking work in the vicinity of services controlled by others within the land? (e.g. roadwork in the vicinity of buried cables or pipe)
2)	What are your procedures for controlling work by others within the land? (e.g. trench excavation across land)  <i>N/A.</i>
3)	To whom do these work procedures apply? Who is excepted
4)	What are your notification procedures? Who is notified of work to be done by yourselves or others within the land and how?
5)	Are permits issued for work to be done in the land by you or others? What sort of information is required in the permit and who approves it?
6)	Other Comments



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<b>FIBRE OPTIC CABLE OPERATORS</b>	
1)	Please advise whether any new installations, changes or improvements to optic fibre cables in the vicinity of the pipeline are anticipated in the future. If so – where?
2)	Please advise the method and equipment used to install fibre optic cable. If plough, please advise machine size for pre-ripping and ploughing.
3)	Please advise the methods and equipment used to maintain / repair the cable, if required. <i>N/A</i>
4)	Please advise whether an event that would require replacement of a section of cable is credible in the location traversed by the pipeline. If this did occur, how would it be replaced, how much time is required to mobilise equipment for the repair, and what notifications to third parties do your procedures require?
5)	Please advise Operator's requirements for construction and maintenance in the vicinity of the cables, that could impose constraints on the pipeline construction.
6)	Other comments



<b>HIGHWAY AND RAIL OPERATORS</b>	
1)	<p>Please advise design loads for:</p> <ol style="list-style-type: none"> <li>1. Road Crossings               <ul style="list-style-type: none"> <li>• Gravel</li> <li>• Bitumen</li> <li>• Highway</li> </ul> </li> <li>2. Rail               <ul style="list-style-type: none"> <li>• Axle load</li> <li>• Engine Weight</li> <li>• Wagon Weight (loaded)</li> <li>• Travel speed</li> </ul> </li> </ol>
2)	<p>Please advise whether any new installations, changes or improvements to road/rail assets in the vicinity of the pipeline are anticipated in the future. If so – where?</p>
3)	<p>Access and Maintenance.</p> <ul style="list-style-type: none"> <li>• In addition to information provide elsewhere, please advise specific requirements for construction and maintenance activities along rail reserve.</li> <li>• Please advise machinery size and bearing load equipment used for derailment recovery:</li> <li>• Please provide any information that would provide pipeline designers with guidance on derailment/accident history along rail, and description of the disposition of engine, wagons, axles etc that could impact the buried pipeline</li> </ul>
4)	<p>Inspection of the pipeline route shows locations where water discharging through culverts installed beneath highway and rail, resulting in extensive erosion downstream of the discharge. Does your authority have a procedure for (a) preventing erosion or (b) maintaining the roadside land in a manner that prevents erosion from occurring? (The problem for the pipeline designer is to establish how deep to install the pipe to prevent it's cover from being eroded).</p>
5)	<p>Have you plans to upgrade or change the design of culverts.</p>
6)	<p>Please advise the railway signal communications system and its installation in the rail easement. What maintenance and/or upgrading of the signalling system is planned.</p>
7)	<p>Please advise whether the rail system involves any electrical impressed or other direct current sources in its operation (that may have the potential to interfere with the cathodic protection corrosion control system on the pipeline).</p>



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POWER TRANSMISSION LINE OPERATORS	
<b>Note: Designers will separately contact operator for engineering details of power transmission lines for use in designing mitigation of induced AC and earth potential rise effects.</b>	
<b>Please advise engineering contact:</b>	
1)	<p>Please advise details of power transmission assets along the pipeline:</p> <ul style="list-style-type: none"><li>• Name</li><li>• Voltage</li><li>• Power</li><li>• Fault Current</li><li>• Fault Clearance times</li><li>• Typical Tower/Pole design</li><li>• Typical conductor configuration</li><li>• Typical Tower/Pole Earth design.</li></ul> <p style="text-align: center; color: blue; font-size: 2em;">N/A</p>
2)	<p>Please advise minimum separation required for:</p> <ul style="list-style-type: none"><li>• Parallel structures</li><li>• Structures in vicinity of Tower/Pole</li><li>• Conductors</li></ul>
3)	<p>Please advise requirements for construction activities in vicinity:</p>
4)	<p>Please advise plans to change/upgrade power lines:</p>
5)	<p>Other Comments</p>



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<b>BURIED METALLIC STRUCTURES (Water, Sewer, Gas, Electric, Telephone etc)</b>	
1)	Please advise whether there is a cathodic protection corrosion prevention system installed on any other pipeline system or water reticulation systems in the vicinity of the pipeline route. <i>Not known at this stage.</i>

<b>CONSTRUCTION – MAINTENANCE EQUIPMENT</b>	
	Construction – Maintenance equipment used by our organisation includes (model, manufacturer, power, weight etc) <ul style="list-style-type: none"><li>• Rippers?</li><li>• Bulldozers ?</li><li>• Graders ?</li><li>• Excavators ?</li><li>• Backhoes ?</li><li>• Rollers ?</li><li>• Trenchers ?</li><li>• Other ?</li></ul> <i>N/A.</i>
	Excavators use the following ground engaging tools and tooth dimensions: <ul style="list-style-type: none"><li>• General purpose teeth</li><li>• "Tiger" teeth</li><li>• "Penetration" teeth</li></ul>



## Possible pipeline threats

Blasting	Bogged Vehicles
Cable installation – plough	Deep ripping to 1200 mm
Deep ripping to 900 mm	Drainage Ditch Maintenance
External Loads – general	External Loads – rail
External Loads – vehicle	Horizontal Boring
Impact	Pipeline Construction
Pipeline Maintenance	Ploughing to 300 mm
Ploughing to 600 mm	Road construction
Sewer / water construction	Trench excavation
Vertical boring	Other

(This list is intended to be comprehensive, but not exhaustive)



ENVIRONMENTAL THREATS	
1)	<p>Please advise whether there are specific threats from the environment to the pipeline, or from the pipeline to the environment, over the pipeline route: (Attach additional pages if required)</p> <p>Threat: N/A .</p> <p>Weeds,</p> <p>Location:</p> <p>Identified in EIS?.</p>