APA Group

Safety Management Study
Wilton South East Precinct Development

Land Use Change
Moomba to Wilton Pipeline and;
Moomba to Botany Ethane Pipeline

DOCUMENT NO: 410-R-01

Prepared by

Venton & Associates Pty. Ltd.
ABN: 86 081 612 053
PO Box 472
Bundanoon NSW 2578

TEL: *+61 2 4884 4470*
FAX: *+61 2 4884 4474*

November 13, 2017

REVIEW AND APPROVAL RECORD

REV	DATE	DESCRIPTION OF RELEASE	PREP'D	REV'D	APPRV'D
0	13/11/17	Issued	PBV		
B	13/11/17	APA comments addressed	PBV		
A	7/9/17	Internal Review	PBV	WC & APA	

Disclaimer

This report has been prepared on behalf of and for the exclusive use of Walker Corporation and APA, and is subject to and issued in accordance with the agreement between Walker Corporation and APA and Venton and Associates Pty Ltd. Venton and Associates Pty Ltd accepts no liability or responsibility whatsoever for it in respect of any use of or reliance upon this report by any third party.

Copying this report without the permission of Walker Corporation and APA or Venton and Associates Pty Ltd is not permitted.

TABLE OF CONTENTS

SECTION **PAGE**

APPENDICES

Appendix 1 Development Drawings

Appendix 2 ALARP Assessment

Appendix 3 SMS Register

Appendix 4 Attendee Register

Changes – Revision A to Revision 0

1. Each mark-up made by APA was accepted, and each comment considered and deleted.
2. A note was added to the summary to record that while the SMS undertook a qualitative ALARP assessment of residual threats, rather than a LOPA, the methodology used was acceptable to APA in this case.
3. Minor editorial corrections were made

1. SUMMARY

This document presents the findings of a Safety Management Study (SMS) assessed by Workshop of stakeholders on August 24, 2017.

The Workshop considered risks associated with the development of the Wilton – South East Precinct to APA's Moomba to Wilton (MSP) natural gas pipeline and its Moomba to Botany ethane pipeline.

The SMS concluded that provided that each pipeline is provided with barrier protection in the form of a reinforced concrete slab or possibly a heavy polyethylene sheet, threats to the pipeline will be controlled to the standard required for these pipelines installed in a residential location class. This form of protection is consistent with the protection applied over each pipeline on the north side of Picton Road, associated with the Bingara Gorge residential development.

This protection is required to extend 1 measurement length (665 metres) south of the Maldon-Dumbarton rail corridor in the case of the MSP. The treatment is not required for the ethane pipeline in this area because it is adequately protected by increased burial depth provided by its construction method.

The protection is also required to extend 665 metres north from the development, over each pipeline. The SMS notes that much of the land on the north side of Picton Road is currently within the 1 measurement length distance of the Bingara Gorge residential development and arguably, should already be treated with barrier protection. The SMS did not resolve responsibility for this protection.

A number of other controls were identified and recorded as actions that are to be addressed prior to the development entering the construction stage. These are in addition to APA's standard requirements for work in the vicinity of gas pipelines.

NOTE:

APA commented in its review that while the SMS format followed that in AS 2555.1, it did not follow APA's current procedure to consider and document the effectiveness of threat controls using the Layer of Protection Analysis (LOPA) methodology. APA noted that it did not nominate this as a current requirement for SMS, and that it will accept the study as reported in this document.

2. BACKGROUND

2.1 GENERAL

The Moomba to Wilton Natural Gas pipeline was completed by The Pipeline Authority in 1976 to transport natural gas from Moomba to Wilton, and thence to Sydney, Wollongong and Newcastle in pipelines owned by AGL. In 1995 The Pipeline Authority constructed a pipeline to transport ethane from Moomba to Botany, to supply a feedstock for the (then) ICI olefines plant.

Both pipelines are now owned by APA.

At the time of construction, Wilton was a small country village, and land use through the region was broad rural. Urban expansion has resulted in progressive residential development at Wilton, progressing south toward Wilton Road. Some of these developments have changed the land use around APA pipelines and this has required treatment of the design and the pipeline to maintain public safety at the standard required for residential land use.

Over the past 3-4 years, planning has been undertaken for a large (15,000 lot) residential and commercial development centred on the Picton Road/Hume Highway intersection.

Walker Corporation is seeking development approval for a 3000 lot residential and light commercial development on the south east quadrant of the intersection. The development will cover approximately 700 metres of the easement containing the APA pipelines south from Picton Road. One of the development consent conditions is that APA agree that the pipeline safety will satisfy the requirements of the technical Standard, AS 2885, for high pressure gas and liquid petroleum pipelines installed in residential areas.

To achieve this, it is expected that treatment will be required to both the development's design and the pipeline.

The method nominated in AS 2885 to assess pipeline safety is a Safety Management Study (SMS). This requires a comprehensive examination of threats to the pipeline and consequences from the pipeline. Where necessary the Study is required to identify additional controls required to reduce the risk to a tolerable level, and in some locations, to a level of "As Low As Reasonably Practicable" (ALARP).

AS 2885 requires that the Study is undertaken by the Pipeline Licensee (APA).

In this case APA requested that Walker Corporation engage Venton and Associates to prepare an analysis of threats and controls for presentation to a workshop of stakeholders for validation.

This report and its attachments presents the findings of the SMS.

3. PIPELINE PROPERTIES

3.1 GENERAL

The parameters of each pipeline are listed in **Table 3-1.**

The critical defect length and the Maximum Axial hole size were calculated by Venton. The remaining information was provided by APA or Walker.

Table 3-1 Pipeline Parameters Relevant to SMS

Item	Unit	MSP	Ethane
Fluid		Compressed natural gas	Dense phase ethane (pseudo liquid0
Outside Diameter	mm	864	219.1
Wall Thickness	mm	9.2	8.1
Pipe Material		API 5L Grade X65	API 5L Grade X60
Design Pressure	kPa	6895	14895
Minimum Yield Strength	MPa	448	413.7
Hoop Stress at Design Pressure	% SMYS	72	49
Total Length	Km	1299	1375
Length within Development	km	0.75	0.75
Measurement Length	m	665	590
Critical Defect Length	mm	141	118[1]
Max. Axial hole for "No Rupture"	mm	94	79[1]
Distance between MLV's	km	17	17
Estimated min. burial depth (locator)	mm	1.4	1.2
Coating		Coal tar enamel	Extruded HDPE
Coating condition		Good	Good
Known Integrity issues		Nil	Nil
Current Location Class (per AS 2885.1)		R2	R2
Location Class after Development		T1	T1
Sign Spacing		per R2	per R2

Note 1: The relatively conservative wall thickness (for pressure) means that the pressure at which the hoop stress is 30% of specified minimum yield strength is 9.3 MPa. At and below this pressure the energy is insufficient to sustain fast tearing fracture. An MAOP reduction to approximately 13 MPa will extend the critical defect length to approximately that of the MSP.

In addition:

- The ethane pipeline was installed by horizontal directional drilling at crossings of the Hume Highway, the Cataract River and the crossing of the future Maldon - Dumbarton rail crossing. In these locations, the pipeline depth is sufficient to remove the risk of external interference by credible threats.

- The MSP will require substantial relocation (by replacement or lowering) should the Maldon - Dumbarton rail be constructed. The development should provide an unencumbered area on the north-west side of the boundary between the development and the rail corridor for construction equipment.
- The pipelines are operated from APA's national control facility. APA maintains an area office for maintenance and service staff at Wilton. Isolation valves at Wilton and Yanderra can be closed remotely in the event of an emergency. Depressurisation following isolation is a manual operation.
- Should an event occur that requires depressurisation, the MSP can be depressurised rapidly (over 3-4 hours) from facilities installed at each MLV. The ethane pipeline requires special depressurisation procedures which restrict the time to full depressurisation to several days.
- APA will require the coating integrity to be tested using the DCVG method before development commences and again following completion of significant construction. Coating defects identified after construction may require rectification at the developers cost.
- APA will require the easement to be delineated prior to construction using a temporary fence. The temporary fence is to be maintained until construction is completed.
- APA will require compliance with a number of standard control methods during the development construction, including:
    - Approval to Work
    - Work Method Statements
    - Statement of machine sizes
    - Vibration monitoring obligations at nominated locations
    - Gas Awareness training for people working within the easement
    - Supervision of work at nominated locations (including road crossings)
    - Where temporary easement crossings are required for construction equipment, installation of temporary load baring structures in accordance with Drawing MW97-0144 (Temporary Heavy Vehicle Crossing for Ethane and Natural Gas Pipelines (Typical Vehicle Crossing).
    - Upgrade of pipeline warning signs to reflect the reduced spacing recommended by AS 2885.1 for residential location class.

3.2 ETHANE PIPELINE – SPECIAL CONDITIONS

This pipeline transports ethane as a dense phase fluid. In this state the fluid behaves similarly to a high vapour pressure liquid. The critical temperature is 32.2°C and critical pressure is 4.9 MPa.

At 20°C (nominal soil temperature) the fluid behaves as a compressed gas up to a pressure of 3.75 MPa, at which the density is 85.7 kg/m^3. At a marginally higher pressure the gas condenses to a liquid with a density of 339.6 kg/m^3. Further pressure increase to design pressure of 14.895 MPa increases the density to 417 kg/m^3. (Note: These properties vary with the fluid or ground temperature).

When pressure is released (such as at a leak, or deliberately), the fluid is discharged as a liquid. The released liquid rapidly vapourises, to form a heavier than air vapour cloud. At atmospheric pressure residual liquid rapidly cools to a minimum temperature of approximately -88°C.

The consequences of these properties are:

- A pipeline leak will continue for a significantly longer period than an equivalent gas pipeline.
- The released fluid is denser than air, raising the possibility that released fluid forms a potentially explosive dense gas cloud, and that the cloud moves downhill under gravity, transporting the fluid to locations where ignition could cause an unexpected risk.
- Special procedures are required to depressurise the ethane pipeline to manage the low temperature associated with depressurisation, and to safely dispose of the dense, cold gas. The equipment required to manage this takes some time to mobilise, further extending the time to depressurise a pipe section, should this be required to manage a leak.
- The pipeline is less sensitive to fast tearing fracture than it would be if it transported gas at the same pressure because the pseudo liquid will depressurise rapidly to a sustained pressure that reflects the temperature-pressure equilibrium condition.

3.3 RESISTANCE TO PENETRATION

Venton calculated the parameters in **Table 3-2** according to the methodology of AS2885.1 Appendix M.

Table 3-2 Resistance to Penetration - Calculated Values

	Tooth Type	"B" Value	CDL (mm)	"No Rupture" Length (mm)	Machine Size to Puncture (t)	Tooth Axial Length (mm)	Rupture or Leak	Puncture Diameter (mm)
MSP	T	B=1	141	94	>45		N/A	N/A
		B=1.3			>45		N/A	N/A
	P	B=1			30	110	L	71
					25	96	N/A	N/A
		B=1.3			20	92	L	58
					15	82	N/A	N/A
Ethane	T	B=1	118	79	>45		N/A	N/A
		B=1.3			45	136	R	118
					40	136	N/A	N/A
	P	B=1			25	96	L	62
					20	92	N/A	N/A
		B=1.3			15	82	L	52
					10	70	N/A	N/A

Notes:

- B=1 is a factor that is deemed to satisfy the requirements of AS 2885.
- B=1.3 is a factor that is deemed to be required when a "no puncture" condition is required.
- When puncture occurs and the tooth axial length is greater than the CDL rupture will occur. For the purpose of this analysis, a margin of 10% is added to the tooth dimension as a small conservative allowance. *This definition is for assessment purposes only, since it is different from the AS 2885 definition for "no rupture" pipe.*
- N/A means that there is no puncture or leak.
- When puncture occurs the hole diameter is assumed to be the area of the tooth cross section when 50% of the tooth enters the pipe. The hole diameter provides a conservative basis for estimating the associated fluid discharge rate.

Venton calculated the mass flow and energy release rates for nominal hole sizes in the ethane pipeline, using the formulae in Crane handbook for liquid discharge through an orifice. These do not properly reflect the behaviour of dense phase ethane, but are considered to provide a reasonable estimate of the discharge for the purposes of this assessment.

The calculated values are presented in Table 3-3.

Table 3-3 Energy Release Rate - Ethane			
Hole Diameter (mm)	**Mass Flow from 14.9 MPa (kg/s)**	**Energy flow from 14.9 MPa (GJ/s)**	**4.7 kW/m^2 Radiation Contour**
10	8.2	0.43	44
30	75.4	3.9	128
75	51.9	27.4	340

4. WILTON SOUTH EAST PRECINCT DEVELOPMENT

4.1 GENERAL

The Wilton South East Precinct (WSEP) Development involves approximately 3000 lots bounded by Picton Road in the north, and the Maldon-Dumbarton rail corridor to the south (and west). The development is a component of the so-called Wilton New Town project, which will ultimately result in approximately 15,000 residential allotments constructed in each quadrant of the intersection between Picton Road and the Hume Highway, and including commercial, shopping and educational facilities.

To the north, the existing Bingara Gorge development will extend west to the Hume Highway, and south to Picton Road. Currently no residential development is contemplated between the Maldon-Dumbarton rail corridor and the Cataract River – this land will remain as semi-rural location class.

Specific development items include:

- The development is expected to take 15 years to full completion/occupancy.
- The first development stage will be in the western end, including the pipeline easement.
- Approximately 750 metres of pipeline easement is included in the development.
- Education facilities will be located at the eastern end of the development, approximately 2000 metres from the pipeline. The eastern end of the development is a higher elevation than the pipeline easement.
- The development will require Picton Road to be widened to 6 lanes.
- Power will be supplied from the regional substation constructed as part of the Bingara Gorge development on the north side of Picton Road. Residential/Commercial service transformers are expected to be small, and generally installed on land excised from a development block (not on footpaths).
- Sewage will be transferred using rising mains from zone collection pits. No gravity sewers will cross the easement.
- Services will cross the pipeline easement at constructed road crossings.
- No significant cuts will be made to land in the vicinity of the pipeline easement.
- Minor to modest (2 m maximum) filling is expected to be required at road crossings. Fill will be feathered to natural ground level beyond the road crossings.
- Planned roads are at “optimum” locations having regard to access obligations from Picton Road and the landform. This has resulted in 2 crossings being designed to cross the easement at an angle, rather than perpendicular.
- The development will be undertaken in stages. Stage 1 will be to the west of the easement, although planned road crossings will be made as part of the first Stage.

5. SMS REVIEW WORKSHOP

5.1 OBJECTIVE

The agreed Workshop objective was:

1. To consider the risks associated with the proposed WSEP development to the natural gas and ethane pipelines – and risks from the pipelines to occupiers/users of the development, and identify controls necessary to reduce the risk to a tolerable level.
2. To assess whether the risks are controlled to a level of ALARP in accordance with AS 2885.1 Clause 4.7.4.
3. To provide a basis for APA to agree to the development (with controls).

5.2 ATTENDEES

The Workshop was attended by representatives of the Developer and his Engineer, and from APA. Mr Venton of Venton and Associates facilitated the workshop. The attendees are listed in Table 5-1.

A representative from Wollondilly Council joined the Workshop briefly to ask whether there were any issues for Council. He departed shortly thereafter.

Table 5-1 Workshop Attendees

Name	Organisation	Representing
Phil Venton	Venton and Associates	Facilitator
Stuart Gander	Walker Corporation	Developer
Gerry Beasley	Walker Corporation	Developer/Planner
Carmela Pelaez	BG&E	Developer Engineer
Ross Larsen	APA	Infrastructure Planning & Protection
Chris Meades	APA	Pipeline Operations
Martin Wong	APA	Mechanical Engineering
Sean Brokman	APA	Pipeline Operations
Mark Walker	Qenos/Gorodok	Ethane Pipeline

5.3 METHODOLOGY

The Workshop was conducted generally in accordance with the process outlined in AS 2885.1. Recognising that APA has in recent times undertaken SMS's for residential developments on the north side of Picton Road, and assuming that controls required for the Walker residential development should be similar to those applied north of Picton Road, the Workshop concentrated on specific threats and consequences associated with the Wilton South East Precinct development.

The Workshop was conducted generally to the agenda shown in **Table 5-2.**

Table 5-2 Attendee List		
Item	**Description**	**Lead Person**
1	Introduction	Facilitator
2	Project Overview presentation (including schedule)	Walker
3	Pipeline Design and Current Protection methods	APA
4	Pipeline integrity issues to be considered (coating, SCC, corrosion, existing flaws etc)	APA
5	APA minimum requirements (incl. those implemented north of Picton Rd)	APA
6	Workshop approach	Facilitator
7	Identify threats and controls, and assess the effectiveness of the controls through 4 headings: 1. Masterplan design (general) 2. Site Construction phase 3. Residential development phase 4. Residential occupation phase Identify additional controls and where necessary, additional actions to reduce risk to "accepted"	Workshop
8	Risk Assess one or more "all controls fail" scenarios in each phase of the project	Workshop
9	Consider whether "controlled" risk satisfies the objective of AS 2885.1 Clause 4.7.4 (and determine whether a high-level workshop assessment is adequate – or whether a formal study is needed)	Workshop
7	Review workshop outcomes and reach a conclusion on whether the Development can proceed	Venton All Workshop Participants

5.4 SUPPORTING DOCUMENTATION

In preparation for the Workshop documentation was provided by each of the participants to provide background on the development and the Licensee expectations in preparation for the Workshop.

Venton provided:

- An SMS record spreadsheet "APA - Safety Management Study - Walker Development - Wilton South East Precinct" identifying threats, controls and a preliminary risk assessment developed by Venton. This document formed the basis for the Workshop.
- Calculations of critical defect length and penetration resistance to AS 2885.
- A Draft Agenda.

Walker provided:

- Masterplan Layout and Gas Easement.pdf.
- Drawing 20170630_Wilton South East Precinct Current Layout.

- Drawing 201703_Wilton_Concept_Gas Easement Plan.pdf.
- Drawing 201703_Wilton_Concept_Gas Easement Plan Crop Bulk Earthwork Overlay Scale 1 to 1,000 at A1.pdf
- Drawing 201703_Wilton_Concept_Gas Easement Plan Crop Scale 1 to 1,000 at A1.pdf
- Drawing S17119-SK-C-0171-B Stage 1 Bulk Earthworks - Underground Utility - Potholing Plan Sheet 1
- Drawing S17119-SK-C-0172-A Stage 1 Bulk Earthworks - Underground Utility - Potholing Plan Sheet 2

APA provided:

- Standard Drawing MW97-0144 Temporary Heavy Vehicle Crossing for Ethane and Natural Gas Pipelines
- Standard Drawing S-C-039-01 Major Road Crossing Full Load Protection Structure
- Standard Drawing S-PL-031-02- Pipeline Protection Slab – Section
- Copy – Letter to NSW Department of Planning & Environment (20/01/17) Proposed rezoning of Wilton South East Precinct

5.5 Threat Assessment – Land Use Change Assessment

The Workshop did not specifically determine the threats against which the pipelines were to be assessed for compliance with AS 2885, and in particular the high consequence area threats. Subsequent to the Workshop, Venton developed the following assessment using experience derived from a number of SMS studies involving residential development.

5.5.1 Commonly Adopted Excavator Threats

In semi-rural land that is not subjected to unusual threat activity, Licensee's typically advise that the design threat should be a 30-35 tonne excavator equipped with twin pointed "tiger" teeth.

The assessment in **Table 3-2** indicates that:

- each pipeline is expected to resist puncture from machines of this size, fitted with tiger teeth.
- each pipeline should resist puncture from smaller (20-25 tonne) machines fitted with single pointed 'penetration" teeth.

Experiments undertaken by Agility using 9.5 mm thick lower strength (X42) pipe reasonably support this assessment.

In residential land that is not subjected to unusual threat activity, Licensee's typically advise that the design threat should be a 15-20 tonne excavator equipped with twin pointed "tiger" teeth. The smaller excavator threat recognises the fact that it is impractical (and unnecessary) to use large machines in residential areas for general excavation work (machines in the 5-10 t range are most often used).

5.5.2 SMS Threat

The excavator threat during the construction phase was assessed as:

- A 35t excavator fitted with tiger teeth, used for excavations associated with construction of the slab protection for the road crossings.
- A 10 t excavator fitted with tiger teeth, used for excavations associated with mechanical protection slabs.

The excavator threat during the residential phase was assessed as a 20 t excavator fitted with tiger teeth used for unauthorised excavation within the easement.

Table 3-2 indicates that each pipeline should reasonably resist penetration from these threats.

5.5.3 Mechanical Protection

The Workshop relied on advice from APA on the design of mechanical protection required to remove the risk of excavator damage to either pipeline. APA advised that their preferred protection is a reinforced concrete slab in accordance with Standard Drawing MW97-0144 (Temporary Heavy Vehicle Crossing for Ethane and Natural Gas Pipelines). This slab is 250 mm thick and extends approximately 1 metre on either side of the pipeline.

A concrete slab in accordance with this drawing is expected to be effective in preventing external interference to the pipeline from excavator, vertical boring and similar threats.

APA also advised that it has recently demonstrated that "heavy" polyethylene sheeting is as effective as concrete slabs, and it is more convenient to manage should it be necessary to remove it for pipeline maintenance. Unfortunately specific details were not provided to the Workshop.

The "heavy" polyethylene protection should be considered as an alternative to concrete slabs, subject to APA's specification, and approval.

5.6 Mandatory Mechanical Protection

The topic was discussed under Agenda Item 5 (APA minimum requirements [incl. those implemented north of Picton Rd]). In that discussion APA advised that they had no mandatory requirements for the pipeline protection.

Notwithstanding this, toward the end of the Workshop, APA advised that they would require each pipeline to be protected against external interference for the length subjected to land use change AND for 1 measurement length north and south of the development. Figure 5-1 illustrates the extent of the MSP measurement length for the new and existing residential developments.

The protection required is a concrete slab complying with Standard Drawing MW97-0144 (Temporary Heavy Vehicle Crossing for Ethane and Natural Gas Pipelines). APA advised that this requirement would provide the same level of external interference protection as applied to the pipelines in the Bingara Gorge residential area.

The Workshop noted that the Bingara Gorge residential development has changed the land use (within 1 measurement length on either side of the pipelines) to location class T1 practically to Picton Road, and consequently the absence of APA's "mandated" protection on the north side of Picton Road means that the pipeline does not currently comply with the provision of AS 2885 in this location.

While the Workshop accepted that mechanical protection should be applied, the commercial responsibility for protection on the north side of Picton Road was not resolved.

Note: While the Workshop nominated reinforced concrete mechanical protection, it is recommended that the APA specified "heavy" polyethylene sheeting be considered, for both operational and cost reasons.

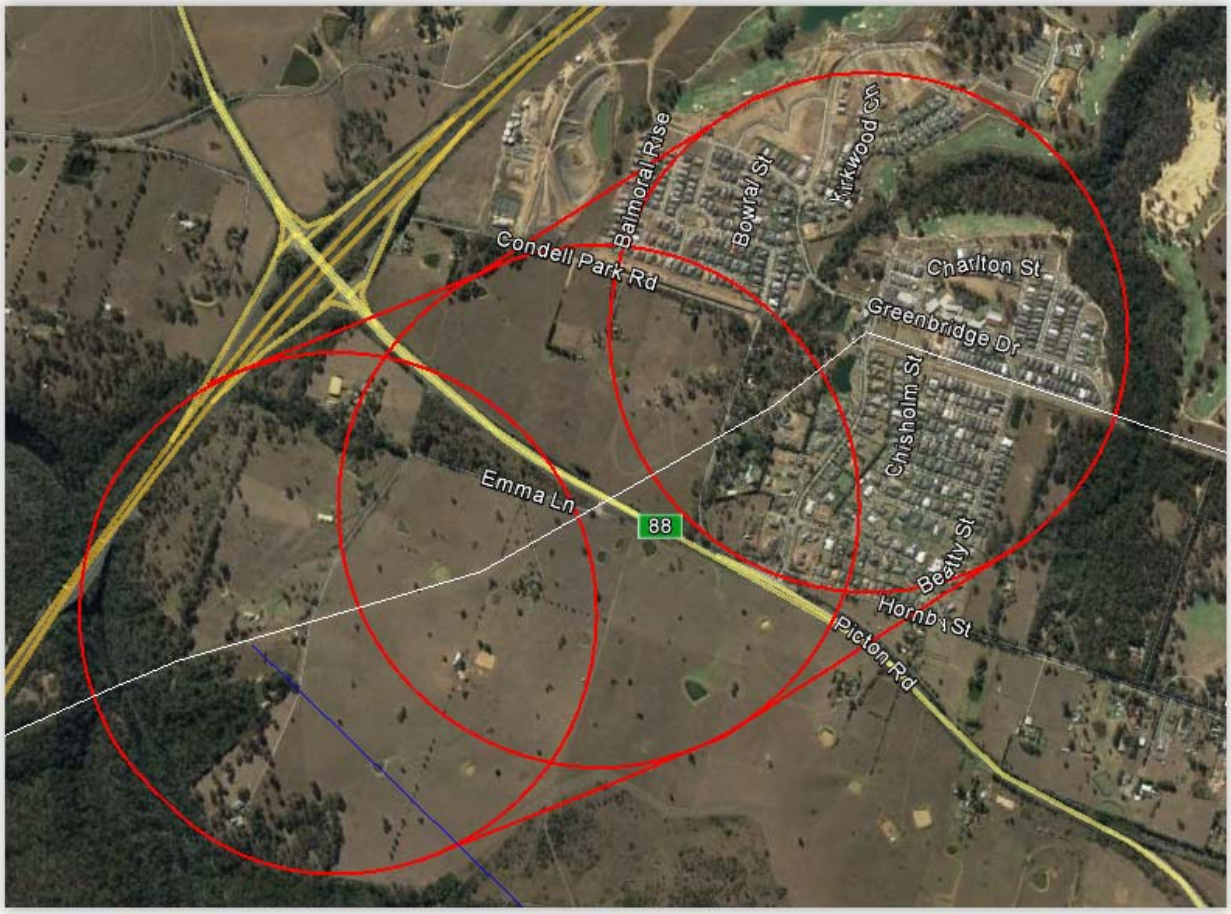


Figure 5-1 Location Class Assessment Area per AS 2885

6. WORKSHOP FINDINGS

6.1 GENERAL

The Workshop concluded that the risks to the pipelines could be controlled to the level required for high pressure pipelines installed in residential areas. The primary control is barrier protection applied over each pipeline to reduce the likelihood of a threat capable of puncturing either pipeline from contacting the pipeline. A number of other controls to address other threats were identified.

Each additional control was nominated as an *action*. Each *action* is required to be completed prior to work commencing.

6.2 FINDINGS THAT AFFECT THE SITE PLAN

The SMS first considered the control of threats associated with the site master plan, and specifically, threats associated with the development design in proximity to the pipeline easement.

Thirteen (13) actions were identified. Of these:

- No change to the development design was required.
- A portion of land is required to be preserved from development on the west side of the easement abutting the north side of the Maldon-Dumbarton rail corridor. This land is considered necessary to provide working space for APA to lower the MSP, should the rail construction proceed. The action on APA is to advise the dimensions or the parcel, while the corresponding action on Walker is to modify the development plan to provide this space.

  Note: The Workshop did not discuss the possibility of the land being returned to residential use once the construction activity is completed. However, Walker should provide for this possibility.
- Mechanical protection of both pipelines was required for the length of the development, and 1 measurement length on either side of the development. It is noted that:
  - The land use on the north side of Picton Road is currently residential (T1). Because of this, mechanical protection for the pipelines according to the methods used for Bingara Gorge development should be installed by APA irrespective of the status of the WSEP.
  - The ethane pipeline was installed by HDD from the Hume Highway to north of the Maldon-Dumbarton rail corridor. Mechanical protection for it terminates at the rail corridor.

The remaining actions are essentially procedural, and have minimal impact on the project cost.

6.3 FINDINGS THAT AFFECT THE SITE CONSTRUCTION

The Workshop considered threats to the pipeline associated with construction activities of the development (earthworks, road construction, utilities installation, landscaping and similar). Most of these threats are generic, reflecting issues that typically arise from a development of this type.

Eleven (11) actions were identified. None of the actions impact on the design of the development. Rather they identify procedural controls, or design check items that represent good practice.

6.4 FINDINGS THAT EXIST DURING RESIDENTIAL CONSTRUCTION

The Workshop considered threats to the pipeline (and from the pipeline to the community) that may arise from multiple building and services contractors accessing the site during the residential construction phase of the development.

Four (4) actions were identified under this category. None of the actions impact on the design of the development. Rather they identify procedural controls, or design check items that represent good practice.

6.5 FINDINGS THAT AFFECT THE FUTURE OF THE DEVELOPED SITE

The Workshop considered threats to the pipeline (and from the pipeline to the community) that are expected to occur throughout the foreseeable life of the development and the pipelines. During this phase, the pipelines are expected to be exposed to only minor threats because the activities are expected to be limited to road and services maintenance, and development of constructed residences. Moreover the pipeline easement will be well marked, and APA's community liaison program will inform the community of the presence of the pipelines.

One (1) action was identified, to develop a MOU with Council to ensure that APA is notified of any development or maintenance activity of which Council is aware, and which has the potential to impact on pipeline safety.

6.6 ALL CONTROLS FAIL

AS 2885.1 includes an obligation for each SMS to consider events that may occur should *all controls fail*.

The philosophy behind pipeline safety is that a number of physical and procedural controls are applied along the pipeline, each of which is either effective, or contributes to the effectiveness of controlling threats to the pipeline.

The *all controls fail* obligation provides a sense check that challenges the SMS findings (which usually conclude that controls are effective. Its purpose is to provide an assessment of the possible consequences of a threat which for some reason manages to escape the threat controls.

Venton proposed the assessment consider:

Case 1: A 10 mm diameter hole in either pipeline, resulting in an extended leak of the contained fluid, with subsequent ignition of the released fluid. A leak of this size is possible from an unidentified corrosion pit.

For this Case, the risk is assessed as *negligible* because:

- The radiation contour is modest (24 and 40 m to 4.7 kW/m^2) for the gas and ethane pipelines respectively.
- Each pipeline is properly protected against external corrosion and is inspected periodically to identify corrosion using appropriate in-line technology.

Case 2: A 30 mm diameter hole in either pipeline, resulting in an extended leak of the contained fluid, with subsequent ignition of the released fluid. A hole of this size is a possible consequence of impact by an excavator of sufficient size to puncture the pipeline, and used with modest aggression. The hole is smaller than the critical defect and growth to rupture is not possible.

For this Case, the risk is assessed as *low* for each pipeline because:

- Each pipeline will be provided with barrier protection that will protect the pipeline from external interference threats. The consequence could only occur if the perpetrator worked recklessly to break the barrier and continue without care to the pipeline.
- The 4.7 kW/m^2 radiation contours were assessed as 112m and 128 m for the gas and ethane pipeline respectively. The consequence of this event was assessed as *major*, but the barrier protection means that threat is scarcely credible.

Case 3: A 75 mm diameter hole in either pipeline resulting in an extended leak of the contained fluid, with subsequent ignition of the released fluid. A hole of this size is a possible consequence of an aggressive and extended impact by a HDD. Again, the hole size is smaller than the critical defect length of each pipeline and growth to rupture is not possible.

For this Case, the risk is assessed as *intermediate*, a result of *hypothetical* frequency and *catastrophic* consequence. This risk level was accepted because:

The 4.7 kW/m^2 radiation consequence distance is 185 m for the gas pipeline, and 340 m for the ethane pipeline. In a residential area, ignition of either plume will cause radiation levels that are likely to result in multiple fatalities, and significantly impact on supply.

The soil conditions in the WSEP area are expected to require HDD's to use tools designed for rock or similar "hard" materials, and this environment will provide support to the drill string that will restrict its ability to deflect around the circumference of the MSP, and hence puncture is a likely consequence. The drill bit will probably deflect around the small diameter ethane pipeline, further reducing the frequency of an event that punctures the pipeline.

This risk level was accepted with management procedures because:

- Threats from HDD's exist for all buried structures, particularly linear structures like pipelines. APA has procedures to manage this threat in all locations and these will be applied within the WSEP development.
- While in some locations where the likelihood of undetected HDD's is higher concrete barrier protection may be used, it is difficult to justify in locations where there is no basis for increased frequency such as the WSEP.
- The likelihood of the threat actually existing largely controlled by the design and installation of services crossing the pipelines as part of the development phase. While it is not impossible for HDD's to be required throughout the life of the development, it is expected that these will be planned and implemented with APA's authorisation, and in accordance with APA's requirements.

7. FUTURE

This SMS provides the basis for APA to advise authorities that they have no objections to the development consent subject to all *actions* being implemented, assessed and closed off prior to the development work commencing. This includes the various obligations for work in the vicinity of pipelines required by APA.

The SMS Worksheet provides space for the action to be described, for it to be assessed and if necessary an additional action implemented, and acceptance of the action. It is recommended that this, or an equivalent document is used for this purpose.

APA should review this site-specific SMS and transfer any relevant threats / actions to the SMS for each pipeline to ensure that they are retained for future reassessment in the periodic SMS revision required by AS 2885.

APPENDIX 1

Development Drawings

Display Hardstand

WAREHOUSE
3,700m2

OFFICE
100m2

GRASSED RESERVE

SHOWROOM
1,750m2

Display Hardstand

SHOWROOM
1,750m2

Display Hardstand

SHOWROOM
3,000m2

Display Hardstand

24.385 WIDE

Hardstand

Hardstand

OFFICE
715m2

WAREHOUSE
5,640m2

OFFICE
250m2

WAREHOUSE
4,650m2

GRASSED RESERVE

AUTHORITY EASEMENT

PIPELINE

Display Hardstand

WAREHOUSE
3,700m2

OFFICE
100m2

GRASSED RESERVE

SHOWROOM
1,750m2

Display Hardstand

SHOWROOM
1,750m2

Display Hardstand

SHOWROOM
3,000m2

Display Hardstand

24.385 WIDE

Hardstand

Hardstand

OFFICE
715m2

WAREHOUSE
5,640m2

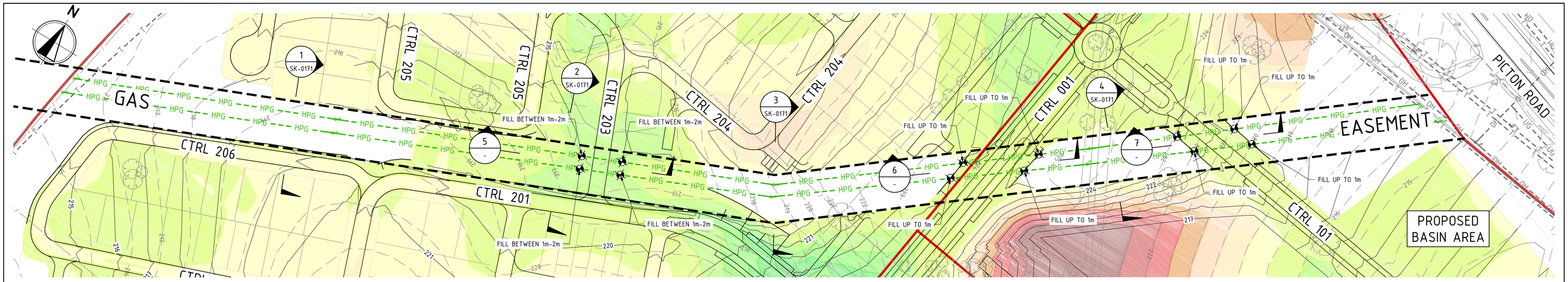
OFFICE
250m2

WAREHOUSE
4,650m2

GRASSED RESERVE

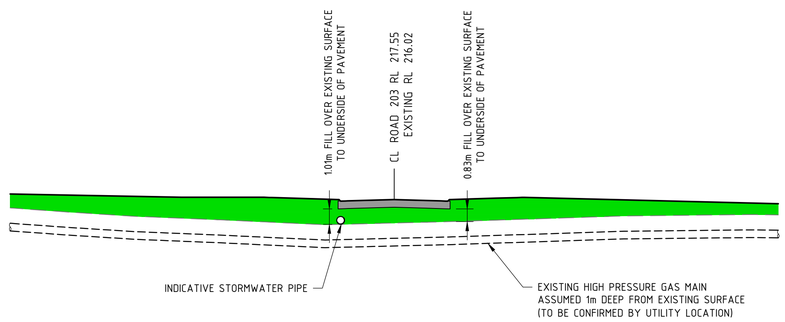
AUTHORITY EASEMENT

PIPELINE



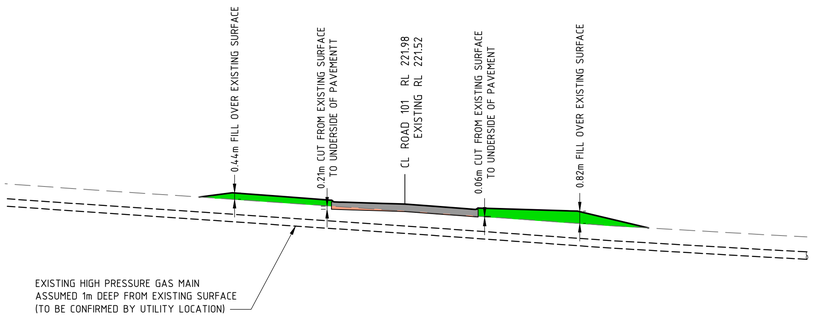
PLAN

SCALE 1:1000



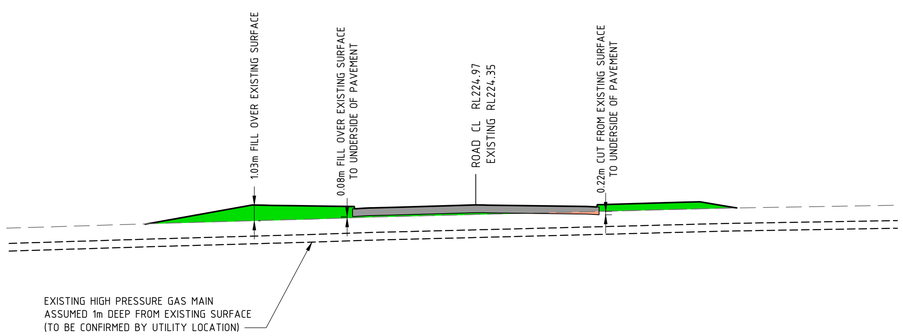
SITE SECTION - GAS EASEMENT 5

SCALE HORIZ. 1:200 VERT. 1:200



SITE SECTION - GAS EASEMENT 7

SCALE HORIZ. 1:200 VERT. 1:200



SITE SECTION - GAS EASEMENT 6

SCALE HORIZ. 1:200 VERT. 1:200

LEGEND

- STAGE BOUNDARY
- 223 FINISHED DESIGN CONTOUR
- 224 EXISTING CONTOUR
- PROPOSED HIGH PRESSURE GAS MAIN POTHOLE LOCATION
- HPG EXISTING HIGH PRESSURE GAS MAIN
- EXISTING SURFACE LEVEL
- FINISHED DESIGN LEVEL

CUT		FILL	
	CUT BETWEEN 0m-1m		FILL GREATER THAN 6m
	CUT BETWEEN 1m-2m		FILL BETWEEN 5m-6m
	CUT BETWEEN 2m-3m		FILL BETWEEN 4m-5m
	CUT BETWEEN 3m-4m		FILL BETWEEN 3m-4m
	CUT BETWEEN 4m-5m		FILL BETWEEN 2m-3m
	CUT BETWEEN 5m-6m		FILL BETWEEN 1m-2m
	CUT GREATER THAN 6m		FILL BETWEEN 0m-1m

REV	DATE	DESCRIPTION	RVD
A	07.07.17	ISSUED FOR INFORMATION	C.K.B.

REVISIONS

SCALE: 0 10 20 30 40 50 60m
SCALE 1:1000 AT A1 SIZE

CLIENT
walker
Walker Corporation
Level 21 Governor Macquarie Tower
1 Farrer Place, SYDNEY NSW 2000 Australia
Telephone +61 8273 9600
Facsimile +61 8273 7400

Sydney Office
L2 8 Windmill St Sydney NSW 2000
P/+61 2 9770 3300
E/info@bgeeng.com
bgeeng.com
BG&E

PROJECT: WILTON JUNCTION

STATUS: ISSUED FOR INFORMATION
NOT TO BE USED FOR CONSTRUCTION

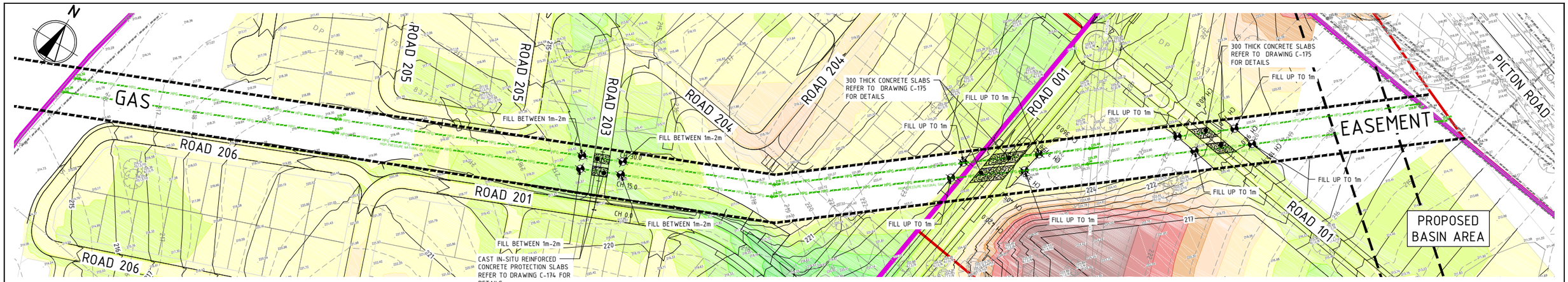
DRAWN	DESIGNED	CHECKED	APPROVED
C.K.B.	C.F.P.	-	C.F.P.

DATUM	GRID	SCALE	
AHD	MGA	AS SHOWN	AT A1 SIZE

TITLE: STAGE 1 BULK EARTHWORKS UNDERGROUND UTILITY POTHOLING PLAN SHEET 2

PROJECT No.	DRAWING No.	REV.
S17119	SK-C-0172	A

P:\BGE\SYD\S17119\100 DRAWS\100 2 CIVIL\AUTOCAD\SKETCHES\S17119-SK-C-0171-0172.DWG
7/07/2017 3:49:39 PM

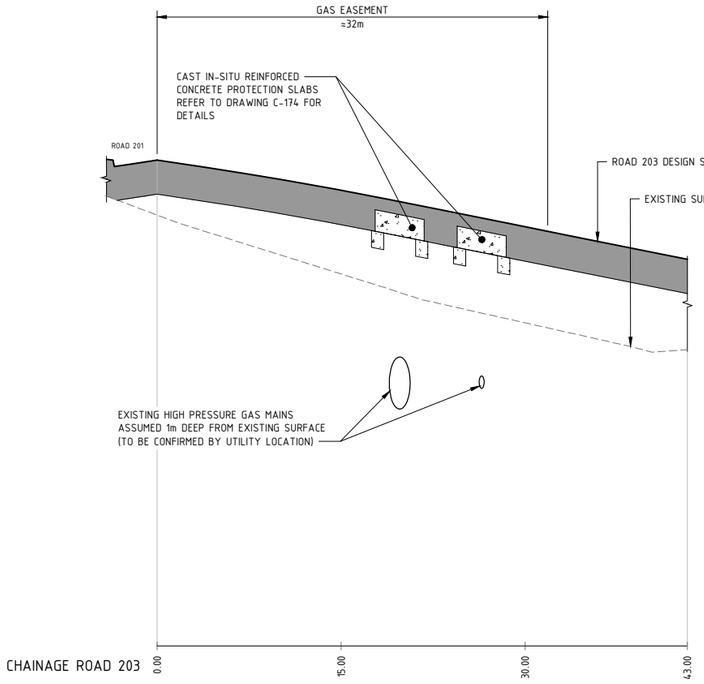


PLAN

SCALE 1:1000

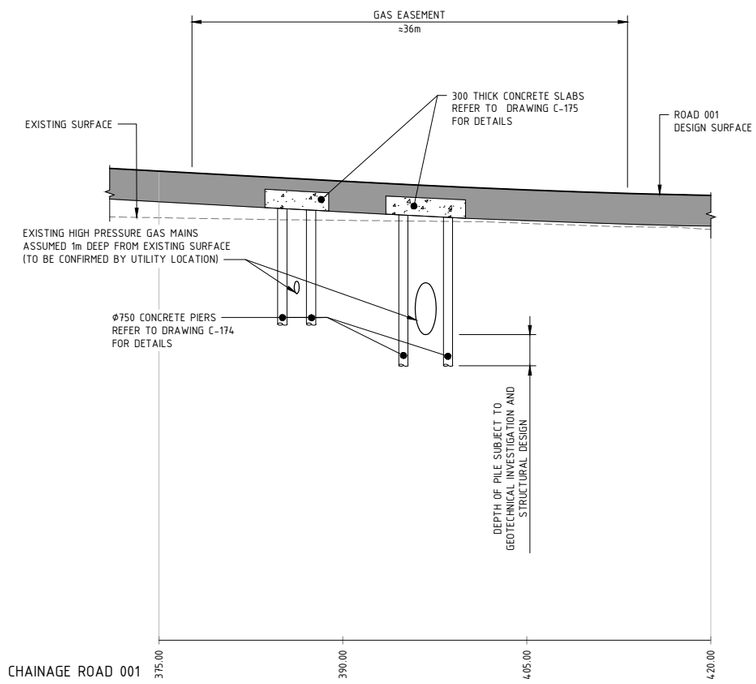
LEGEND

REFER TO SKETCHES SK-C-171 AND SK-C-172 FOR LEGEND



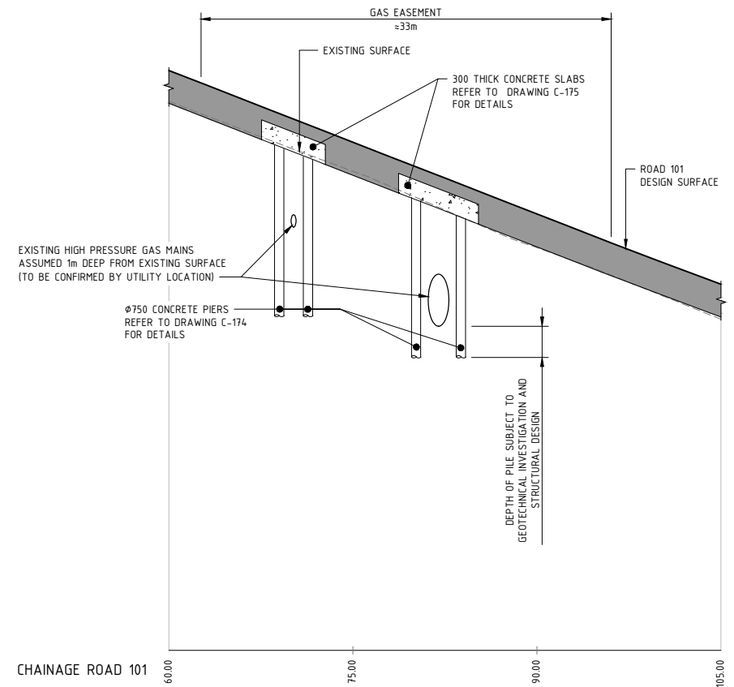
ROAD 203 PROFILE AND GAS EASEMENT

SCALE 1:250H 1:50V



ROAD 001 PROFILE AND GAS EASEMENT

SCALE 1:250H 1:50V



ROAD 101 PROFILE AND GAS EASEMENT

SCALE 1:250H 1:50V

REV	DATE	DESCRIPTION	RVD
A	01.08.17	ISSUED FOR INFORMATION	C.K.B.

REVISIONS

REVISIONS

SCALE
0 10 20 30 40 50 60m
SCALE 1:1000 AT A1 SIZE
0 2.5 5.0 7.5 10 12.5 15m
SCALE 1:250 AT A1 SIZE
0 0.5 1.0 1.5 2.0 2.5 3.0m
SCALE 1:50 AT A1 SIZE

CLIENT

walker

Walker Corporation
Level 21 Governor Macquarie Tower
1 Farrer Place, SYDNEY NSW 2000 Australia

Telephone +61 8273 9600
Facsimile +61 8273 7400

Sydney Office
L2 2 Whitehall St Sydney NSW 2010
P/+61 2 9720 2300
E/hello@bgeng.com.au
bgeng.com.au

BG&E

PROJECT

WILTON JUNCTION

STATUS
ISSUED FOR INFORMATION
NOT TO BE USED FOR CONSTRUCTION

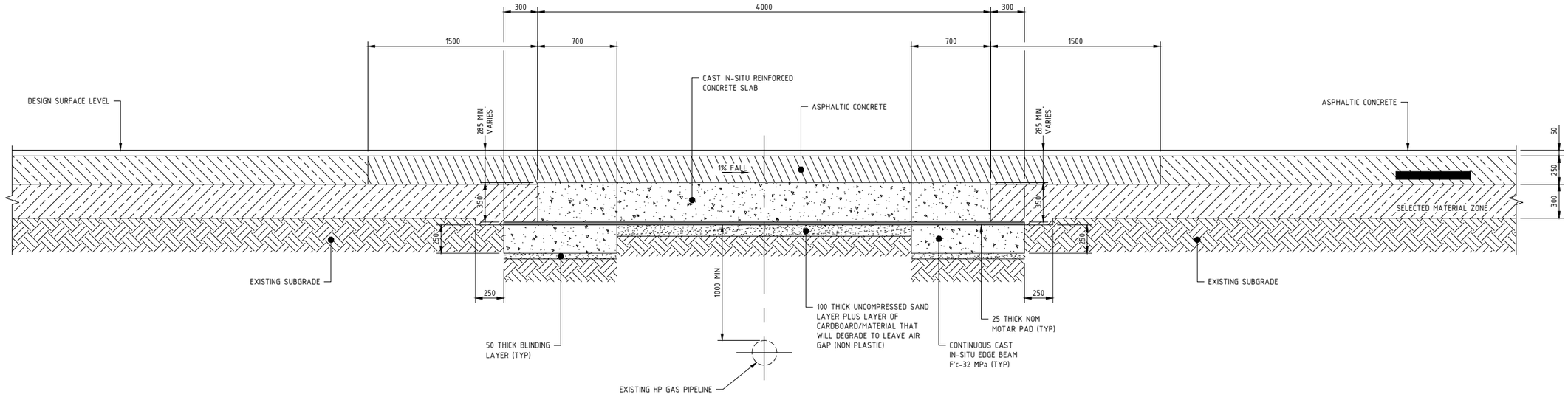
DRAWN	DESIGNED	CHECKED	APPROVED
C.K.B.	C.F.P.	-	C.F.P.

DATUM	GRID	SCALE	
AHD	MGA	AS SHOWN	AT A1 SIZE

TITLE
STAGE 1 BULK EARTHWORKS UNDERGROUND UTILITY POTHOLING PLAN SHEET 3

PROJECT No.	DRAWING No.	REV.
S17119	SK-C-0173	A

P:\BGE\SYD\S17119\100 DRAWN\100.2 CIVIL\AUTOCAD\SKETCHES\S17119-SK-C-0171-0173.DWG
1/08/2017 11:20:47 AM



TYPICAL DETAIL

SCALE 1:20

NOTES

1. DIMENSIONS ARE IN MILLIMETRES
2. CONCRETE EXPOSURE CLASSIFICATION: B2
3. CONCRETE MIX SHALL BE IN ACCORDANCE WITH RMS SPECIFICATION B80 ANNEXURE E, WITH A MINIMUM 28 DAY COMPRESSIVE STRENGTH OF 40MPa
4. MINIMUM COMPRESSIVE STRENGTH OF BLINDING LAYER SHALL BE 20MPa

REV	DATE	DESCRIPTION	RVD
A	08.07.17	ISSUED FOR INFORMATION	C.K.B.

REVISIONS

REV	DATE	DESCRIPTION	RVD

REVISIONS

SCALE: 0 0.2 0.4 0.6 0.8 1.0 1.2m
SCALE 1:20 AT A1 SIZE

CLIENT
walker
Walker Corporation
Level 21 Governor Macquarie Tower
1 Farrer Place, SYDNEY NSW 2000 Australia
Telephone +61 8273 9600
Facsimile +61 8273 7400

Sydney Office
L2 2 Windmill St Sydney NSW 2000
P/+61 2 9320 2300
E/[redacted]
[redacted]
BG&E

PROJECT: WILTON JUNCTION

STATUS: ISSUED FOR INFORMATION
NOT TO BE USED FOR CONSTRUCTION

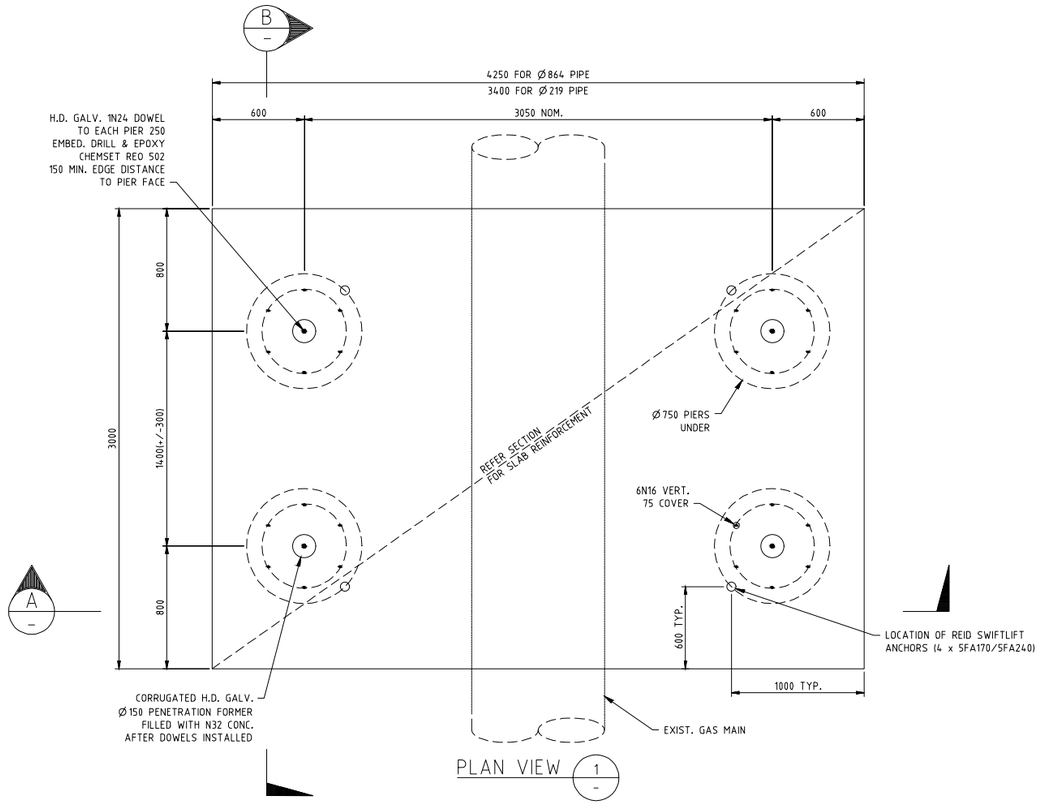
DRAWN	DESIGNED	CHECKED	APPROVED
C.K.B.		-	C.F.P.

DATUM	GRID	SCALE	
AHD	MGA	AS SHOWN	AT A1 SIZE

TITLE: GAS PIPEPLINE - APA
TYPICAL PIPELINE PROTECTION
DETAIL - SHEET 1

PROJECT No.	DRAWING No.	REV.
S17119	SK-C-0174	A

P:\BGE\SYD\S17119\100 DRAW\100.2 CIVIL\AUTOCAD\SKETCHES\S17119-SK-C-0174.DWG
11/08/2017 11:27:53 AM



PLAN VIEW 1

TYP. PROTECTION MODULE

GENERAL NOTES:

1. CONCRETE TO HAVE 28 DAY COMPRESSIVE STRENGTH OF 32MPa FOR PIERS, 50MPa FOR CROWN UNIT.
2. CROWN UNIT TO BE PLACED ON MORTAR BEDDING.
3. ALL DIMENSIONS IN mm UON.
4. SLAB LENGTH MIN 300mm LONG.
5. ALL REINFORCEMENT SHALL BE GRADE D500N COMPLYING WITH AS3600-2001.
6. PIPE PROTECTION STRUCTURE IS TO FOLLOW ALIGNMENT OF PIPE.
7. TOP AND BOTTOM REINFORCEMENT TO HAVE 30mm COVER.

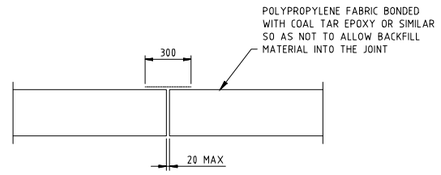
DESIGN LOADS:

1. TRAFFIC LOADS:
   - × W80
   - × A160
   - × M1600
   - × S1600
   - × HLP320

   AS SPECIFIED IN AS5100
2. CONSTRUCTION LOADS:
   - × 637E SERIES 2 SCRAPER

DOWEL TOLERANCE:

N24 DOWELS TO ACHIEVE 150 EDGE DISTANCE TO PIER FACE AND 25 CLEARANCE TO CORRUGATED SLEEVE.



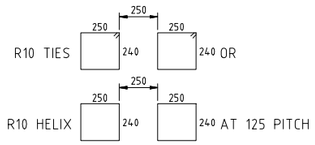
JOINT DETAIL BETWEEN CROWN UNITS

CROWN REMOVAL & REINSTATEMENT PROCEDURE:

1. INSTALL Ø100 VERTICAL CORE THROUGH CONCRETE SURROUNDING DOWELS AND CUT JOINTING MATERIAL.
2. LIFT CROWN.
3. REPLACE MORTAR BEDDING AND BOND BREAKER TO TOP OF PIER.
4. REPLACE CONCRETE FROM INSIDE CORRUGATED SLEEVES AND AROUND DOWELS.
5. REPLACE CROWN.
6. FILL CORRUGATED SLEEVES WITH N32 CONC.
7. REMOVE AND REPLACE JOINTING MATERIAL.

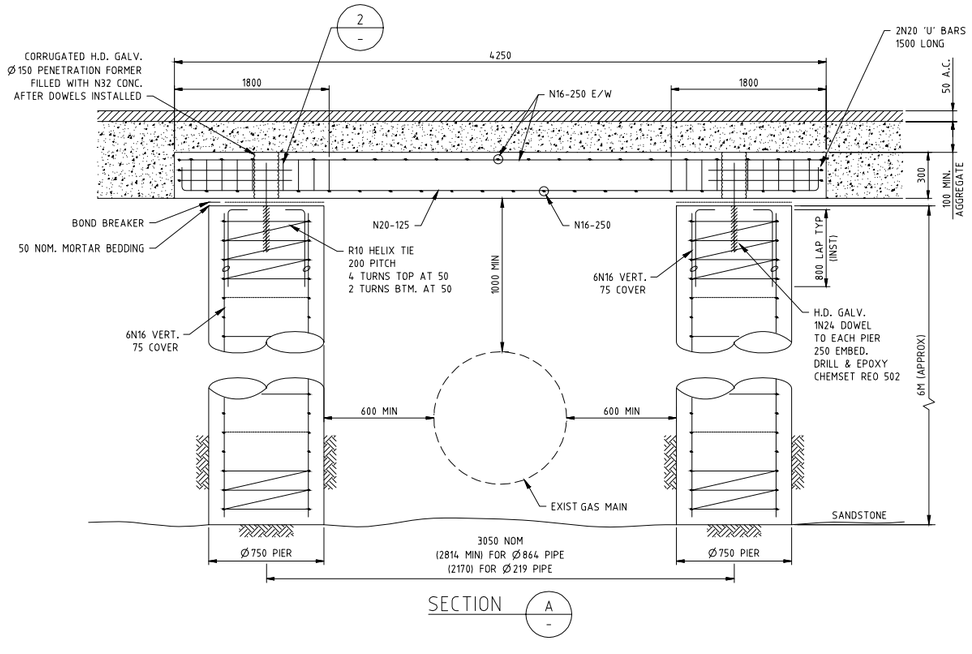
LIFTING NOTES:

1. CONCRETE STRENGTH AT TIME OF LIFT TO BE 15MPa.
2. LIFT TO BE MADE USING GANTRY CRANE IN THE YARD AND MOBILE HYDRAULIC CRANE ON SMOOTH, WELL COMPACTED TRACK ON-SITE.
3. DYNAMIC IMPACT FACTOR TAKEN AS Kd=1.7.
4. MINIMUM FACTOR OF SAFETY IS 2.5.
5. SLING ANGLE TO BE 60 DEGREES MAX. SLING LENGTHS SL=3.0m (4 OF TIED TO AN EQUALISING TRIANGLE). PLEASE NOTE THAT SHORT SLINGS MAY OVERLOAD THE LIFTING ANCHORS.
6. MASS OF THE UNITS CALCULATED AT CONCRETE DENSITY OF 24kN/m3 (9.37 TONNE FOR 4.25 x 3.0m UNIT).

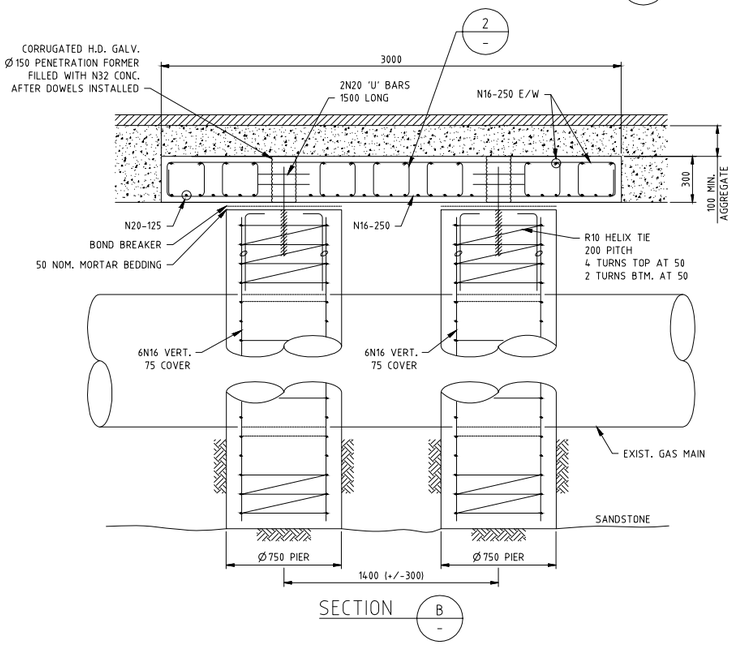


* TIES TO BE FULL LENGTH OF SLAB AND AT 500 CTRS

DETAIL 2



SECTION A



SECTION B

REV	DATE	DESCRIPTION	RVD
A	01.08.17	ISSUED FOR INFORMATION	C.K.B.

REVISIONS

REV	DATE	DESCRIPTION	RVD

REVISIONS

SCALE: 0 0.2 0.4 0.6 0.8 1.0 1.2m — SCALE 1:20 AT A1 SIZE

CLIENT: walker

Walker Corporation
Level 21 Governor Macquarie Tower
1 Farrer Place, SYDNEY NSW 2000 Australia

Telephone +61 8273 9600
Facsimile +61 8273 7400

Sydney Office
L2 2 Windmill St Sydney NSW 2000
P/+61 2 9720 2300
E/[redacted]

BG&E

PROJECT: WILTON JUNCTION

STATUS: ISSUED FOR INFORMATION
NOT TO BE USED FOR CONSTRUCTION

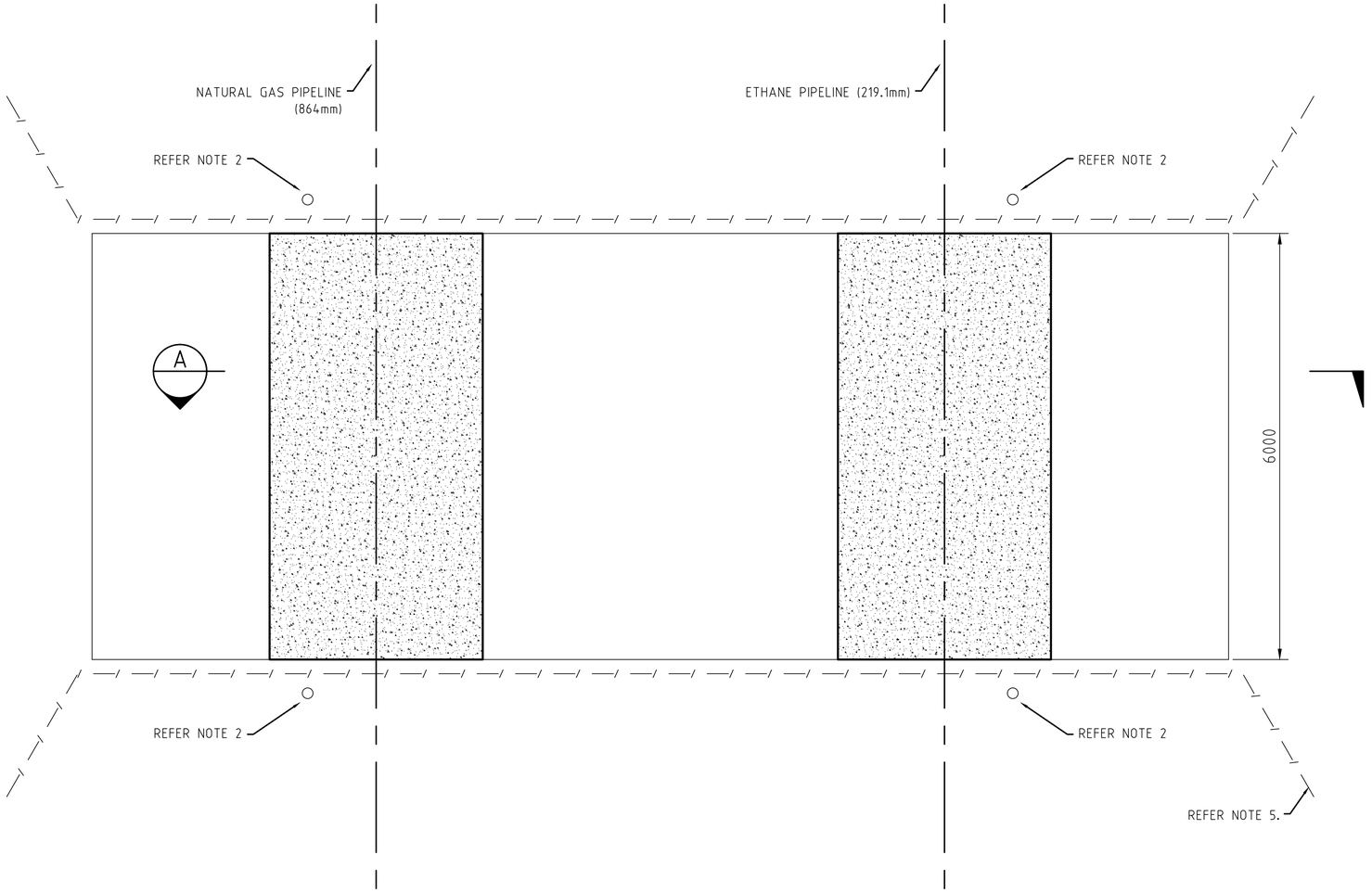
DRAWN	DESIGNED	CHECKED	APPROVED
C.K.B.	C.F.P.	-	C.F.P.

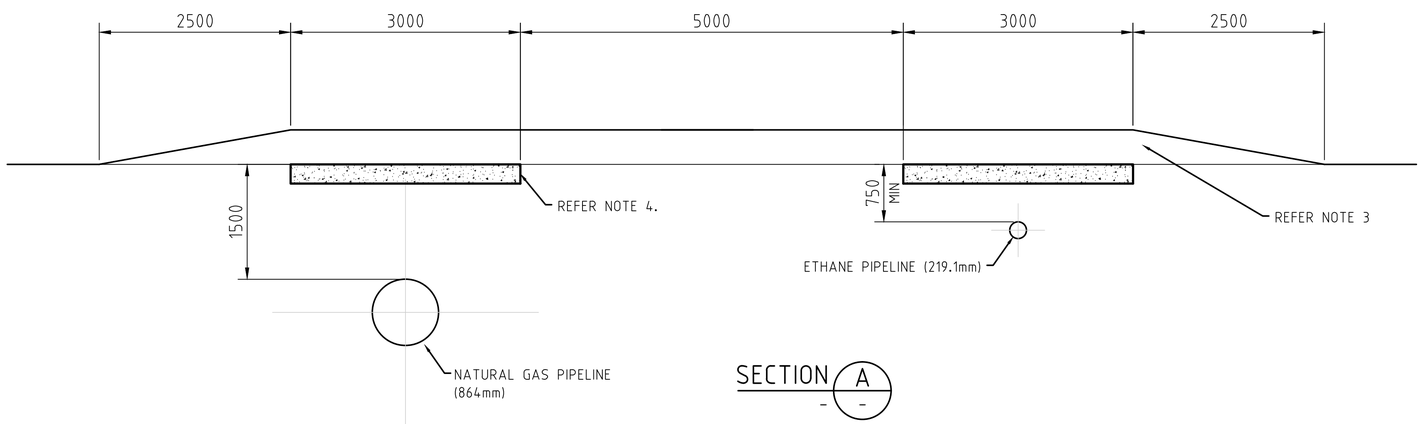
DATUM	GRID	SCALE	
AHD	MGA	AS SHOWN	AT A1 SIZE

TITLE: STAGE 1 BULK EARTHWORKS PIPELINE PROTECTION SLAB DETAIL - SHEET 2

PROJECT No.	DRAWING No.	REV.
S17119	SK-C-0175	A

P:\BGESYD\S17119\100 DRAWI\100.2 CIVIL\AUTOCAD\SKETCHES\S17119-SK-C-0175.DWG
1/08/2019 11:35:27 AM





SECTION A - -

NOTES

1. THIS IS ONLY A TYPICAL DRAWING. APA ENGINEERING MAY REQUIRE ADDITIONAL MEASURES DUE TO SITE CONDITIONS.
2. DOUBLE MARKER OFFSET SIGNS REQUIRED.
   - 2.1. DANGER PLATE S90-12-3
   - 2.2. MARKER INSTALLATION S90-11-3
   - 2.3. OFFSET MARKER S90-9-2
   - 2.4. LOCATION FOR ONLINE MARKER POSTS S13-09-2
3. COMPACTED ROAD BASE RAMP OVER CONCRETE SLAB. DEPTH OF ROAD BASE TO BE 250mm ABOVE SLAB.
4. EXCAVATE 250mm OF TOPSOIL, CONCRETE INSITU CAST CONCRETE SLAB CAST INSITU 250mm THICK 20mPa. (MINIMUM) 1 LAYER SL82 MESH PLACED CENTRALLY. CURING DURATION & COMPRESSION STRENGTH SHALL BE ASSESSED TO BE SATISFACTORY BY THE INSTALLATION/CONSTRUCTION SUPERVISOR. FOR APPROVAL BEFORE READY FOR STARTUP OPERATIONS
5. FENCE TO BE INSTALLED (IF NONE EXISTS) TO ENSURE VEHICLE CROSSING IS USED AT ALL TIMES. REFER S92-10-6

REV	PROJ No	REVISION	DATE	DRW	DES	CHK	APP	REFERENCE DRGs	DRG No
A	267541	ISSUED FOR INFORMATION	22/09/15	SS	SS	MW	MW		

□OR □□ORMA□□O□ O□□

APA Group

A1

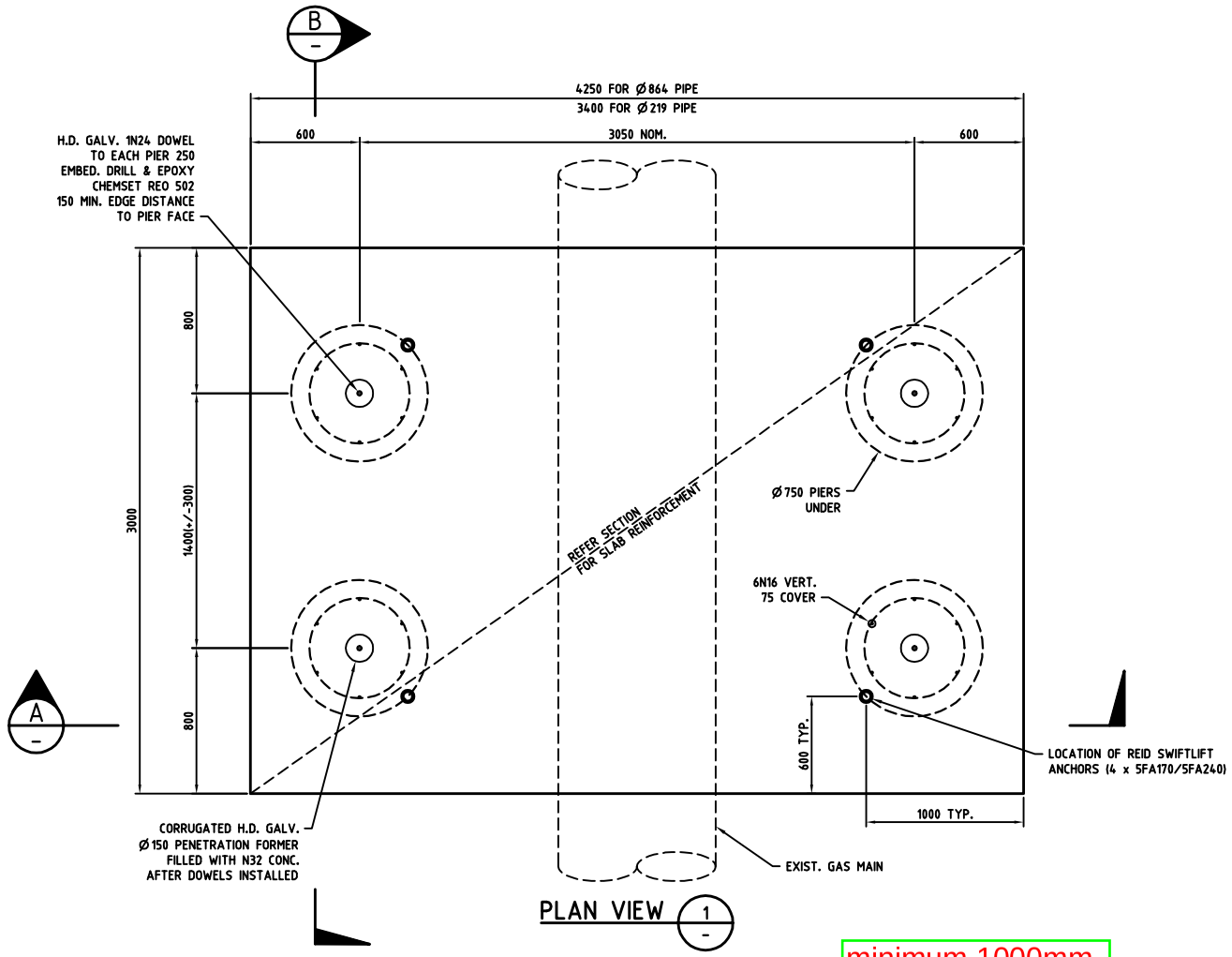
	NAME	DATE
DRAWN	SS	15.06.15
DESIGNED	MW	15.06.15
VALIDATED		
ACCEPTED		
SCALE		

APA STANDARD DRAWING

TEMPORARY HEAVY VEHICLE CROSSING FOR ETHANE AND NATURAL GAS PIPELINES

TYPICAL DRAWING VEHICLE CROSSING

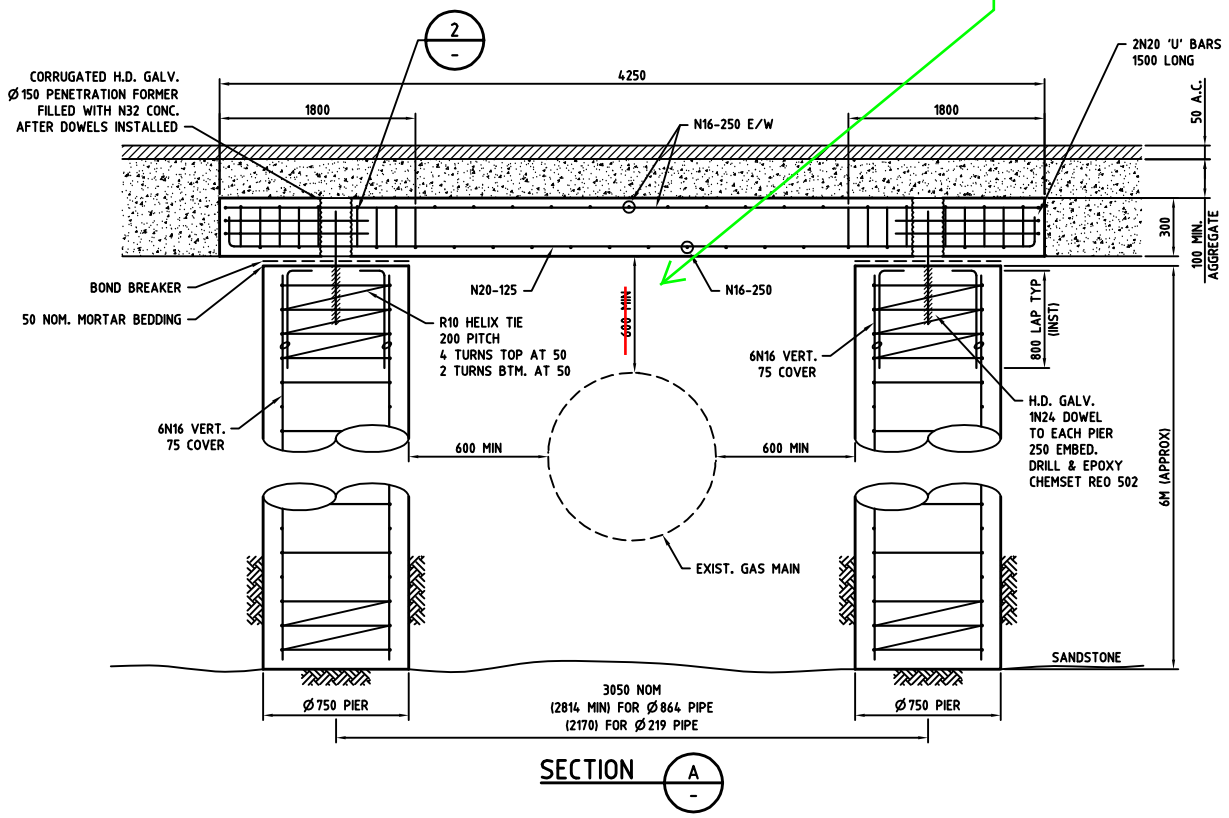
PROJECT No	DRG No	REV
	MW97-0144	A



PLAN VIEW 1

TYP. PROTECTION MODULE

minimum 1000mm



SECTION A

GENERAL NOTES:

1. CONCRETE TO HAVE 28 DAY COMPRESSIVE STRENGTH OF 32MPa FOR PIERS, 50MPa FOR CROWN UNIT.
2. CROWN UNIT TO BE PLACED ON MORTAR BEDDING.
3. ALL DIMENSIONS IN mm UON.
4. SLAB LENGTH MIN 300mm LONG.
5. ALL REINFORCEMENT SHALL BE GRADE D500N COMPLYING WITH AS3600-2001.
6. PIPE PROTECTION STRUCTURE IS TO FOLLOW ALIGNMENT OF PIPE.
7. TOP AND BOTTOM REINFORCEMENT TO HAVE 30mm COVER.

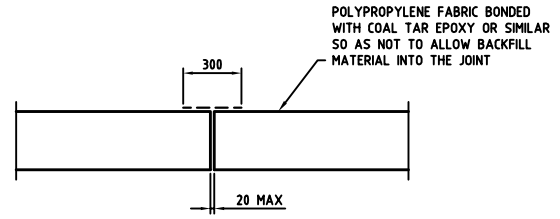
DESIGN LOADS:

1. TRAFFIC LOADS:
   - * W80
   - * A160
   - * M1600
   - * S1600
   - * HLP320

   AS SPECIFIED IN AS5100
2. CONSTRUCTION LOADS:
   - * 637E SERIES 2 SCRAPER

DOWEL TOLERANCE:

N24 DOWELS TO ACHIEVE 150 EDGE DISTANCE TO PIER FACE AND 25 CLEARANCE TO CORRUGATED SLEEVE.



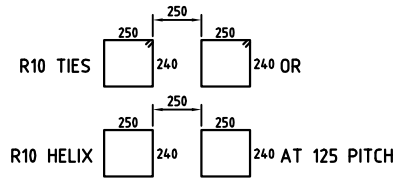
JOINT DETAIL BETWEEN CROWN UNITS

CROWN REMOVAL & REINSTATEMENT PROCEDURE:

1. INSTALL Ø100 VERTICAL CORE THROUGH CONCRETE SURROUNDING DOWELS AND CUT JOINTING MATERIAL.
2. LIFT CROWN.
3. REPLACE MORTAR BEDDING AND BOND BREAKER TO TOP OF PIER.
4. REPLACE CONCRETE FROM INSIDE CORRUGATED SLEEVES AND AROUND DOWELS.
5. REPLACE CROWN.
6. FILL CORRUGATED SLEEVES WITH N32 CONC.
7. REMOVE AND REPLACE JOINTING MATERIAL.

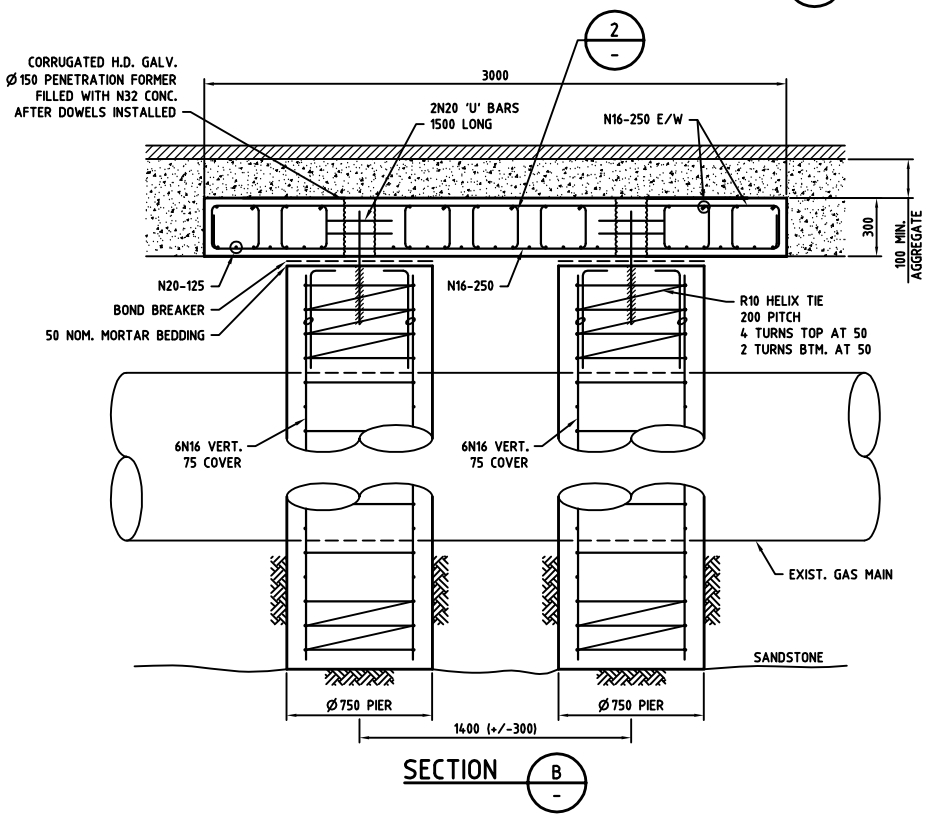
LIFTING NOTES:

1. CONCRETE STRENGTH AT TIME OF LIFT TO BE 15MPa.
2. LIFT TO BE MADE USING GANTRY CRANE IN THE YARD AND MOBILE HYDRAULIC CRANE ON SMOOTH, WELL COMPACTED TRACK ON-SITE.
3. DYNAMIC IMPACT FACTOR TAKEN AS Kd=1.7.
4. MINIMUM FACTOR OF SAFETY IS 2.5.
5. SLING ANGLE TO BE 60 DEGREES MAX. SLING LENGTHS SL=3.0m (4 OF TIED TO AN EQUALISING TRIANGLE). PLEASE NOTE THAT SHORT SLINGS MAY OVERLOAD THE LIFTING ANCHORS.
6. MASS OF THE UNITS CALCULATED AT CONCRETE DENSITY OF 24kN/m3 (9.37 TONNE FOR 4.25 x 3.0m UNIT).



* TIES TO BE FULL LENGTH OF SLAB AND AT 500 CTRS

DETAIL 2



SECTION B

SYM	REVISION	PROJECT ENGINEER	DATE	DRAWN	DATE	CHECKED	DATE	PROJECT MANAGER	DATE	CLIENT	DATE
0	APPROVED FOR CONSTRUCTION			M.BICKLEY	07.06.11	K.HOOGESTEGER	07.06.11				
A	ISSUED FOR REVIEW			M.BICKLEY	19.05.11						

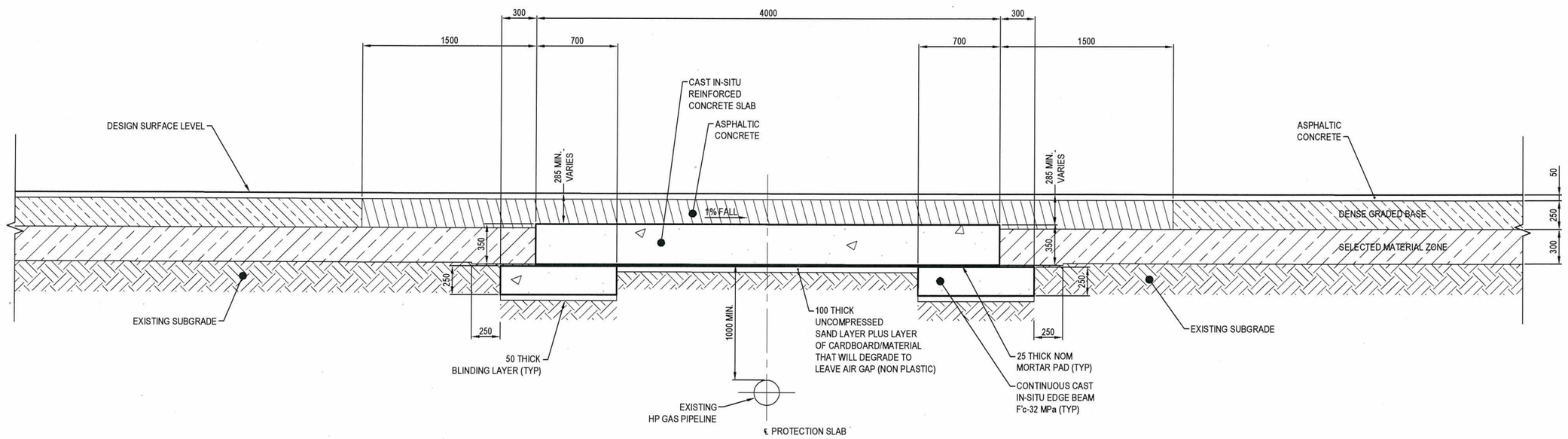
CLIENT

APA Group

STANDARD DRAWING

MAJOR ROAD CROSSING
FULL LOAD PROTECTION STRUCTURE

SCALE	DRAWING NUMBER	REVISION
1:20	S-C-039-01	0



SECTION
SCALE 1:20

GENERAL NOTES

1. DIMENSIONS ARE IN MILLIMETRES.
2. STATIONS AND REDUCED LEVELS ARE IN MILLIMETRES.
3. CONCRETE EXPOSURE CLASSIFICATION: B2.
4. CONCRETE MIX SHALL BE IN ACCORDANCE WITH RTA SPECIFICATION B80.
5. ANNEXURE E, WITH A MINIMUM 28 DAY COMPRESSIVE STRENGTH OF 40MPa.
6. MINIMUM COMPRESSIVE STRENGTH OF BLINDING LAYER SHALL BE 20MPa.

REV	PROJ No	REVISION	DATE	DRW	DES	CHK	APP
0	35669	ISSUED FOR USE	08.12.15	MDB	MW	MW	
B	35669	ISSUED FOR ENGINEERING REVIEW	18.11.15	MDB	MW	MW	
A	35669	ISSUED FOR REVIEW	16.11.15	MDB			

REFERENCE DRGs

DRG No

APA Group

A1

	NAME	DATE
DRAWN	M.BICKLEY	16.11.15
DESIGNED	M.WONG	4.12.15
VALIDATED	M.WONG	4.12.15
ACCEPTED	V.GROVER	8.12.15

SCALE 1:20

STANDARD DRAWING

PIPELINE PROTECTION SLAB - SECTION

DETAIL

PROJECT No

DRG No S-PL-031-02

REV 0

APPENDIX 2

Land Use Change ALARP Assessment

A2 GENERAL

Clause 4.7.4 of AS 2885.1 requires an assessment of at least 5 alternatives that could reduce the risk in locations where land use has changed from that for which the pipeline was designed, to a more demanding land use.

The alternatives considered in the assessment are required to be compared using the As Low As Reasonably Practicable (ALARP) methodology nominated in AS 2885. The definition is: *The measure of whether ALARP has been achieved is if the cost of reducing the risk is GROSSLY DISPROPORTIONATE to the benefit gained. The reduction in risk has to be insignificant when compared to the cost required.*

The alternative chosen to control risk to the standard required for the new location class must demonstrate that it is ALARP

The Workshop conducted a subjective ALARP assessment, which is documented in Section 6 of the SMS Record spreadsheet.

The Workshop noted that each pipeline practically satisfies the high consequence area obligations (no rupture and energy release rate ≤10 GJ/s) for the threats to which there is a reasonable likelihood of the pipelines being exposed in a residential area because of the conservative wall thickness of each pipeline.

Table A2-1 summarises the ALARP assessment. The assessment notes that the existing pipelines practically satisfy the residential (T1) location class obligations because of their wall thickness. However previous assessments by APA as part of the Bingara Gorge development considered that mechanical protection of each pipeline offered a significant risk reduction for a modest capital cost. The route identified for relocation of the pipelines is shown in Figure A2-1.

The costs of the other alternatives considered is 10+ times the cost or mechanical and procedural methods to achieve essentially the same risk reduction. Accordingly, the mechanical and procedural protection solution is considered to satisfy ALARP criteria, and it should be implemented.

Table A2-1 ALARP Assessment Land Use Change

Risk Reduction Method	Risk Reduction provided	Assessed Cost	Comment
Do Nothing	Nil – Existing risk is nearly tolerable	Nil	Arguable that the existing pipelines satisfy no rupture and energy release rate for identified threats, but inconsistent with the risk reduction methods considered necessary for the Bingara Gorge development.
MAOP Reduction	Modest. It will reduce the radiation consequence distance for a given hole.	If each pipeline was fitted with MOP limiter, the cost is in the order of $10-15 million. If MAOP limiting facility was installed (duty/standby devices), the cost is likely	The MSP currently operates at 60-70% of MAOP, in part a result of the distance from the Young compressor station. The ethane pipeline currently operates at a

Table A2-1 ALARP Assessment Land Use Change			
Risk Reduction Method	**Risk Reduction provided**	**Assessed Cost**	**Comment**
	Increase the tolerable hole size for "no rupture"	to be in the order of $20 million	pressure lower than MAOP for the same reason.
Pipe Replacement	Risk Eliminated	The cost to replace both pipelines in the affected area is expected to be in the range of $10-14 million	Pipe replacement was not considered necessary in the Bingara Gorge development
Pipe Relocation	Risk Eliminated	Relocation of both pipelines along the south and east side of the development, and then north to the Wilton Gate station is approximately 6 km. The estimated cost for both pipelines is $19-24 million	Most costly option, but will resolve MSP crossing of the Maldon-Dumbarton rail, and resolve pipeline safety issues between the rail and Wilton Gate station.
Modify Land Use	N/A		Land use change is impractical.
Mechanical Protection and Procedural Controls	External interference threat is controlled. Risk reduced to low	Cost for both pipelines is estimated to be $2.6 million. This includes treatment of the affected easement and 125 m north of Picton Rd, and for the MSP, the distance to the Cataract River	This method is already assessed by APA as being ALARP for the pipeline in the Bingara Gorge development. The cost may be reduced if APA's heavy polyethylene matting is used. The ethane pipeline is protected south from the Maldon-Dumbarton rail corridor by depth of cover, achieved by HDD. The cost to treat 665 metres of pipeline north of Picton Rd is approximately $1.6 million. APA/Walker to negotiate to determine responsibility for this work.

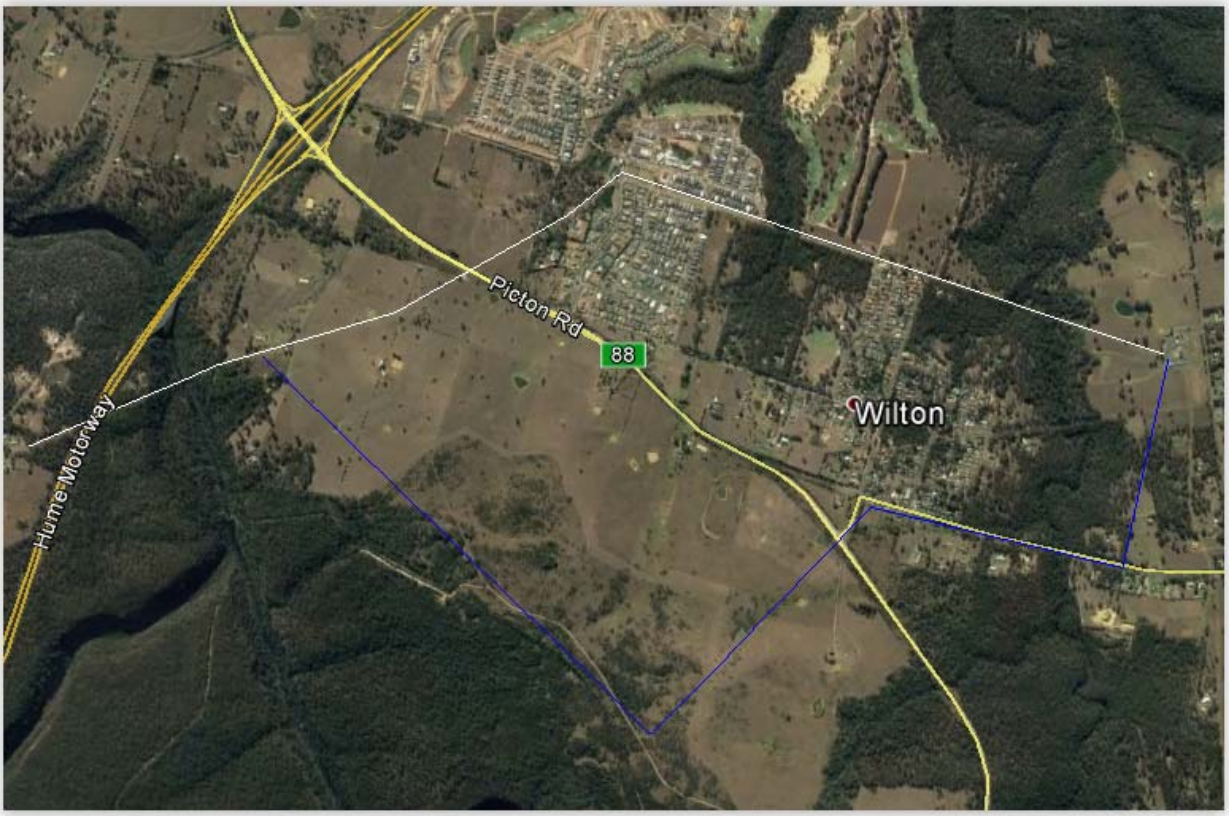


Figure A2-1 Pipeline Relocation Option (Blue Line)

APPENDIX 3

SMS Record

APA - Safety Management Study - Walker Development - Wilton South East Precinct

	MSP	Diameter	864 mm	Steel Grade	X65 448 MPa Yield Stress	Critical Defect	141 mm		Hoop Stress at MAOP	72	% of SMYS							
		Wall Thickness	9.2	MAOP	**6.9 MPa**	Initiation Toughness			Hoop Stress at Operating Press.	40-70	% of SMYS							
		Measurement Length	665 m															
	Ethane	Diameter	219.1 mm	Steel Grade	X60 414 MPa Yield Stress	Critical Defect	118 mm		Hoop Stress at MAOP	49.3	% of SMYS							
		Wall Thickness	8.1	MAOP	**14.895 MPa**	Initiation Toughness			Hoop Stress at Operating Press.	25-49.3	% of SMYS							
		Measurement Length	590 m						Pressure for hoop stress 30% SMYS	9.3	MPa							

Item	Pipeline	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
Development Masterplan Issues												6	#N/A			
										*	*	6	#N/A			
1	**Both**	Road crossings two 2 dual carriageway and 1 single. External load and external interference threat	Yes	Cover and wall thickness for pressure containment only. Load bearing concrete slab to be constructed over each pipeline	Crossings designed and constructed to APA equirements. Construction supervised by APA. Protection design to APA Standard Drawing S-C-039-01 piered slab design.	Design effective in controlling failure risk	No	No	Crossing detail designs will be subject of a separate safety assessment, including work method statement assessment	*	*	6	#N/A	Controls identified to be transferred to DCP. Detailed design to be approved by APA and specific construction controls issued.	**1** **2**	**Walker (GB)** **Walker/APA**
2	**Both**	2 roads will cross at approx 45° to centreline - APA prefers close to 90° Threat pipeline noy correctly located in future, External loads and interference	Yes	Cover and wall thickness for pressure containment only Load bearing concrete slab over each pipeline	Crossings designed and constructed to APA equirements. Construction supervised by APA. Protection design to APA Standard Drawing S-C-039-01 piered slab design.	Design effective in controlling risk	No	No	Crossing detail designs will be subject of a separate safety assessment, including work method statement assessment. Enhanced design may be required because of oblique crossing	*	*	6	#N/A	Dispensation sought for crossing angle limitation because characteristics of the site prevent effective design for a 90° crossing Consider extending then length of the protective slab to provide additional width that could be used for contraflow in the event that APA needed to undertake maintenance work on part of the pipeline. Detailed design to be approved by APA and specific construction controls issued.	**3** **4**	**Walker** **APA**
3	**Both**	Sensitive Developments in measurement length	No	Standard wall thickness and burial depth	Primary school and sporting park well beyond 665 m (>1800 m)	None	No	No	Other open spaces identified on the plan are <10% and do not require consideration as sensitive areas.	*	*	6	#N/A	Define sensitive land use per Hazards SEPP & having consideration of AS 2885. Note in the DPC that sensitive uses should not be permitted within the measurement length of either pipeline	**5**	**APA** **Walker**
4	**Both**	Potentially Sensitive Developments in measurement length	Yes	Standard wall thickness and burial depth	8 Commercial (warehouse/Showroom sites) within measurement length	Leak to 10 GJ/s	Yes	Yes	The pipelines are confined within the easement where procedural protection and possible additional physical protection will control external interference. Locztion class I APA to consider including tenants etc in stakeholder awareness program	Hypothetical	Catastrophic	2	Intermediate	This will remain a residual risk. It is impractical to relocate the pipelines. Slabbing will reduce the potential leak rate significantly and reduce the severity to *MAJOR* , and the risk to *LOW*. Slabbing is required - see Action 6		**Walker (see Action #)**
5	**Both**	Land use change R2 to T1	Yes	Both pipelines are currently designed and approved to location classification R2.	Additional protection must satisfy "no rupture" and energy release rate requirements of AS 2885 (Clause 4.7.2 and 4.7.3), and ALARP study (Clause 4.7.4). Neither pipeline satisfies this requirement without additional physical protection. Will physical protection over each pipeline be effective in reducing the design threat to one which is too small to initiate rupture. Must extend 1 measurement length on either side of development.		Yes	Yes	See ALARP assessment at the end of this spreadsheet and documented in the Workshop Report Appendix. Mechanical protection is considered effective.	Remote	Catastrophic	2	High	1) ALARP report is required. Propose to document the discussion on effectivenss of mechanical protection in reducing the potential hole below CDL. 2) APA to assist with costs for HDPE slabbing provide to facilitator for report. 3) APA to advise extend of additional protection to south for each pipeline recognising the ethane pipe was installed by HDD. 4) APA to consider responsibility for the additional protection on north side of Picton road, recognising that development suggests that the pipe protectoni does not comply with the 1 measurement length rule. 5) ALARP report to be reviewed by participants and each to agree.	**6**	**APA, Facilitator, Participants See Assessment at end of spreadsheet and in the report**
6	**Both**	HDD Threats from services installation	Yes	Nil	1) Services designed to cross at road crossings. 2) Where impractical, Special crossings to APA design approval and construction supervision. 3) Future services crossings prohibited without APA approval	MSP - Leak or metal loss Ethane - Rupture or metal loss	Yes	Yes	This threat exists on north side of Picton Road, and at other locations subject to urban encroachment. APA manage the risk procedurally. There is no reason to believe that these procedures should not be effective at this location, recognising the proximity of APA's Appin office	Remote	Severe	4	Low	Consider redundant conduits in road X designs. Add to DCP	**7**	**Walker (both)**

APA - Safety Management Study - Walker Development - Wilton South East Precinct

MSP	Diameter	864 mm	Steel Grade	X65 448 MPa Yield Stress	Critical Defect	141 mm		Hoop Stress at MAOP	72	% of SMYS				
	Wall Thickness	9.2	MAOP	**6.9 MPa**	Initiation Toughness			Hoop Stress at Operating Press.	40-70	% of SMYS				
	Measurement Length	665 m												
Ethane	Diameter	219.1 mm	Steel Grade	X60 414 MPa Yield Stress	Critical Defect	118 mm		Hoop Stress at MAOP	49.3	% of SMYS				
	Wall Thickness	8.1	MAOP	**14.895 MPa**	Initiation Toughness			Hoop Stress at Operating Press.	25-49.3	% of SMYS				
	Measurement Length	590 m						Pressure for hoop stress 30% SMYS	9.3	MPa				

Item	Pipeline	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
7	Both	Changed Isolation Valve Spacing	Yes	Nil	AS 2885 recommends spacing reduces from "as Required" to 15 km (Table 4.6.4).	Prolonged depressurisation time if there is a failure. Consequence probably not changed.	No	No	Development on north side of Picton Road has been accepted without installing additional valves. The actual distance to next upstream valve is 17 km (Yanderra). This is considered close enough to the recommended maximum spacing. Seems unreasonable to suffer disruption and risk associated with installation of additional valves on either pipeline - particularly if threats of damage by external threats are controlled. Additional valve will reduce depressurisation time but should a leak catch fire, it will not change the consequence.	Hypothetical	Major	3	Low	Agreed that there is no risk benefit in an additional valve, while operational benefit is small. Slabbing will reduce frequency and failure mode (See threat #). The cost to install 2 valves is likely to be >$10M, and no significant risk reduction will be achieved for the ethane pipeline because special depressurisation procedure is required. If there is a leak with ignition, the damage will be caused before the depresurisaton can be effected. For these reasons no ALARP study required		
8	Both	Future threat - Maldon Dumbarton rail	Yes	N/A	Future threat Ethane pipeline is designed to recognise the proposed design for the rail. MSP will require treatment.	Work to be done to a special procedure. Consequence is disruption to residents, and potential to make pipeline modification unnecessrily difficult	No	No	This threat could result from construction of the rail - currently planned, but no prospect of it being constructed. APA indicate that relocation of theMSP would be required to clear the rail. Pipeline relocation likely to impact on development infrastructure. Impact, risk and control cannot be assessed until there is a firm proposal.	*	*	6	#N/A	Currently no intention to proceed with this rail construction. However if it does proceed APA will need sufficient space for the pipeline to be lowered (space for the stopple/bypass. APA to consider its approach to satisfy the rail, and advise Walker for this reservation to be included in the development design including access.	8	APA Walker (to provide)
9	Both	Residential lots abut easement boundary - threat from owner/occupiers undertaking activities that could damage pipelines	Yes	Depth of cover >750 Wall thickness effective against modest external force	APA community liaison and contractor liaison, DBYD Slabbing (Threat #)	Residential development creates a consequence, but no change in threat to the pipeline.	No	No		*	*	6	#N/A	Treat residents as stakeholders in community liaison activity.	9	APA
10	Both	Road abuts Easement boundary - threat vehicles enter easement - external loads, surface damage	No	Depth of cover >750 Wall thickness effective against modest external force	Not effective	Nil	No	No	Typical road vehicles are unable to penetrate soil to pipeline depth, even when the soil is damp and soft. At worst there may be a localised load insufficient to damage pipeline.	*	*	6	#N/A			
11	Both	Threat to people from pipeline damage 1 measurement length upstream and downstream of development	Yes	Existing installation and existing procedures		Leak or rupture within 1 measurement length with ignition could cause damage / injury	Yes	Yes	Slabbing will reduce the frequency to hypothetical and hence the risk to low.	Hypothetical	Major	3	Low	Slabbing required for 1 measurement length north and south of development. Not required for ethane pipeline south of Rail corridor because of extra depth provided by HDD It is noted that the space between Picton Rd and the Bangara Gorge residential development is within the measurement length for that development and is not slabbed. This should be APA responsibility to rectify, since it is a current non-compliance with AS 2885	10 11	Walker APA
12	Both	Failure of either pipeline within 1 measurement length north or south of the development from a pre-existing pipeline condition	Yes	N/A	APA integrity management procedures and processes	Pipeline rupture	Yes	Yes	APA has good knowledge of the condition of both pipelines and advised the Workshop that there is no evidence of a pre-existing condition that could cause failure.	Hypothetical	Catastrophic	2	Intermediate	While this risk is identified as INTERMEDIATE, given that APA has no evidence of a preexisting condition that could cause failure (from in-line and coating integirty inspections), this threat can be treated as not credible. ALARP assessment is not required.		
13	MSP	Coating degradation - maintenance undesirable in new subdivision	Yes	N/A	Inspect & repair before development	No failure - but extensive pipeline maintenance in a new development probably undesirable for developer	No	No	APA advise that DCVG inspection before and after construction will be required to assess whether coating damage has resulted from constructon activities.	*	*	6	#N/A	Undertake coating defect survey before and after construction - identify locations for repair and repair prior to site works. If barrier protection is reqired, then this should be undertaken as part of the barrier installation.	12	APA
14	Both	Future extension of development south and west (beyond proposed rail	Yes	Incresed wall thickness and burial depth			No	No	Currently no extension of recidential development is planned. Expect that DPE will designate as R2. Additional protection for 1 measurement length will be sufficient.	*	*	6	#N/A	Nil		

APA - Safety Management Study - Walker Development - Wilton South East Precinct

	MSP	Diameter	864 mm	Steel Grade	X65 448 MPa Yield Stress	Critical Defect	141 mm		Hoop Stress at MAOP	72	% of SMYS					
		Wall Thickness	9.2	MAOP	**6.9 MPa**	Initiation Toughness			Hoop Stress at Operating Press.	40-70	% of SMYS					
		Measurement Length	665 m													
	Ethane	Diameter	219.1 mm	Steel Grade	X60 414 MPa Yield Stress	Critical Defect	118 mm		Hoop Stress at MAOP	49.3	% of SMYS					
		Wall Thickness	8.1	MAOP	**14.895 MPa**	Initiation Toughness			Hoop Stress at Operating Press.	25-49.3	% of SMYS					
		Measurement Length	590 m						Pressure for hoop stress 30% SMYS	9.3	MPa					

Item	Pipeline	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
15	Both	External load 1-2 m fill each side of Road Crossing CTRL203	Yes	Incresed wall thickness and burial depth throught he affected area		Pipeline stress exceeds allowable. No credible pipeline failure mode. Possible damage to MSP coating.	No	No	Primary concern is external load from machines constructing the fill. Where heavy equioment is used to compact fill APA require a load bearing slab is installed for temporary crossing to standard drawing MW97-0144. Note in general fill areas where compaction is modest and small equipment is used to spread fill, APA may offer dispensation for construction to MW97-0144 .					APA to consider dispensation from the load bearing slab protection where Walker construction plan shows that this work will be undertaken with "small" equipment and to an approved procedure Refer to Threat 2.03B	**13**	**APA/Walker**
16	Both	External load 1 m fill each side of RX CTRL001 & 101	Yes	Incresed wall thickness and burial depth throught he affected area		As threat 15	No	No						As Threat 15		
										*	*	6	#N/A	as above		
Phase 2 - Land Development Phase												6	#N/A			
2.01	Both	External loads from unauthorised construction equipment causing coating damage	Yes	Increased wall thickness and cover. Pipelines ~6 m from easement boundaries	APA site access procedures. Easement fenced except at designated crossings. (temporary - ATF or agreed)	Metal loss may occur in the long term. APA procedures for DCVG and pigging are expected to detect metal loss well before leakage occurs	No	No		*	*	6	#N/A	DCVG survey before and after the land development phase to identify any changes in the coating condition that may have resulted from construction activity Install temporary fencing except at designated crossings or worksites with other protection through to completion of construction. Note: Define "Construction Completion". Induction for pipeline awarenenss. APA suggest authrsed workers in easement wear special coloured Hi Vis vest	**14** **15** **16** **18**	**APA & Walker** **Walker** **APA & Walker** **Walker**
2.02A	MSP	External loads from unauthorised construction equipment causing pipeline damage	Yes	Increased wall thickness and cover. Pipelines ~6 m from easement boundaries	APA site access procedures. Easement fenced except at designated crossings.	Minor Deflection - possible damage to CTE Coating	No	No	No loss of containment so risk assessment not really required. Risk assessed for APA management.	Remote	Minor	5	Negligible			
2.02B	Ethane	External loads from unauthorised construction equipment causing pipeline damage	Yes	Increased wall thickness and cover. Pipelines ~6 m from easement boundaries	APA site access procedures. Easement fenced except at designated crossings.	Minor Deflection - no damage	No	No	No loss of containment so risk assessment not really required. Risk assessed for APA management.	*	*	6	#N/A			
2.03A	MSP	Impact - from unauthorised earthworks during land development	Yes	Increased wall thickness and cover. Pipelines ~6 m from easement boundaries	APA site access procedures. Easement fenced except at designated crossings.	Dent and gouge (shallow)	No	No	No loss of containment so risk assessment not really required. Risk assessed for APA management.				#N/A			
2.03B	Ethane	Impact - from unauthorised earthworks during land development	Yes	Increased wall thickness and cover. Pipelines ~6 m from easement boundaries	APA site access procedures. Easement fenced except at designated crossings.	Dent & Gouge - Puncture remotely possible if impact is aggressive	Yes	Yes		Remote	Minor	5	Negligible	Limit size of excavator to a size below the puncture risk (APA notes that 12 t used elsewhere)	**19**	**Walker**
2.04A	MSP	External loads from authorised construction equipment causing coating damage (Crossing Construction)	Yes	Increased wall thickness and cover. Pipelines ~6 m from easement boundaries	Special design and construction procedures as approved by APA. Potholing & Survey to locate pipelines prior to any work. APA supervisor during all work on site. Easement fenced except at designated crossings.	Minor Deflection - possible damage to CTE Coating	No	No	Refer to EPCRC research - loads from shallow burial.				#N/A			
2.04B	Ethane	External loads from authorised construction equipment causing coating damage (Crossing Construction)	Yes	Increased wall thickness and cover. Pipelines ~6 m from easement boundaries	Special design and construction procedures as approved by APA. Potholing & Survey to locate pipelines prior to any work. APA supervisor during all work on site. Easement fenced except at designated crossings.	Minor Deflection - no damage	No	No	Refer to EPCRC research - loads from shallow burial				#N/A			
2.05	Both	External loads from authorised construction equipment causing pipeline damage (Crossing Construction)	Yes	Increased wall thickness and cover. Pipelines ~6 m from easement boundaries	Special design and construction procedures as approved by APA. Potholing & Survey to locate pipelines prior to any work. APA supervisor during all work on site. Easement fenced except at designated crossings.	n/a	No	No					#N/A			
2.06	Both	Impact - from authorised earthworks during land development (Crossing Construction)	Yes	Increased wall thickness and cover. Pipelines ~6 m from easement boundaries	Special design and construction procedures as approved by APA. Potholing & Survey to locate pipelines prior to any work. APA supervisor during all work on site. Easement fenced except at designated crossings.	n/a	No	No					#N/A			

APA - Safety Management Study - Walker Development - Wilton South East Precinct

MSP	Diameter	864 mm	Steel Grade	X65 448 MPa Yield Stress	Critical Defect	141 mm		Hoop Stress at MAOP	72	% of SMYS				
	Wall Thickness	9.2	MAOP	**6.9 MPa**	Initiation Toughness			Hoop Stress at Operating Press.	40-70	% of SMYS				
	Measurement Length	665 m												
Ethane	Diameter	219.1 mm	Steel Grade	X60 414 MPa Yield Stress	Critical Defect	118 mm		Hoop Stress at MAOP	49.3	% of SMYS				
	Wall Thickness	8.1	MAOP	**14.895 MPa**	Initiation Toughness			Hoop Stress at Operating Press.	25-49.3	% of SMYS				
	Measurement Length	590 m						Pressure for hoop stress 30% SMYS	9.3	MPa				

Item	Pipeline	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
2.07	**Both**	Pipeline coating damage from blasting used to loosen soil for earthwork cuts	No	N/A			No	No	Blasting not permitted	*	*	6	#N/A			
2.08	**Both**	Easement damage (landslip) resulting from inadequately stabilised batters in cut areas	No	N/A	Earthworks design Soil stability analysis	Easement damage and possible environmental impacts	No	No	Earthworks design shows no cuts that could result in landslip Retaining walls will be provided at cut locations - current design indicates that the maximum retaining wall height is 1 m.	*	*	6	#N/A	Shaping of any cut needs to be off easement.	**20**	**Walker**
2.09	**Both**	Pipeline damage (displacement following landslip) resulting from inadequately stabilised batters in cut areas	No	Pipeline girth welds should overmatch line pipe strength	Earthworks design Soil stability analysis Pipeline girth welds may not overmatch adjacent pipe	Failure unlikely, but possible - some elastic strain and possible minor plastic strain APA advise overmatching assessment not needed	No	No	May not be a credible threat. Workshop supports this conclusion.	*	*	6	#N/A			
2.10	**Both**	Erosion resulting from runoff concentrating at drains where fill is placed	Yes	Pipeline cover	Earthworks design Hydraulic Design	Localised erosion over the easement	No	No	Environmental controls imposed on Walker during construction phase expected to manage environmental risk. Should there be an event, APA would require the easement to be restored promptly to the levels that currently exist. Catchment is small and consequent erosion potential is small.	*	*	6	#N/A			
2.11	**Both**	Trench Excavation across a pipeline with impact on the pipeline	Yes	Cover Pipeline wall thickness	Crossings will be at designated locations and constructed to an approved design, under APA supervision.		No	No	Crossing currently planned for CTRL 203 only. Construction to procedures approved for that crossing.	*	*	6	#N/A			
2.12	**Both**	Crossing construction by boring (incl. HDD)	Yes	Cover Pipeline wall thickness	Crossings will be at designated locations and constructed to an approved design, under APA supervision.		No	No	No crossings requiring HDD are currently planned	*	*	6	#N/A			
2.13	**Both**	Horizontal Boring using smaller HDD machines for utility (gas, water, communication etc.) connection to houses with potential to contact the pipeline	No				No	No	Not credible because utilities servicing residences will be installed in streets, and no services will be supplied from the easement or the freeway reserve	*	*	6	#N/A			
2.14	**Both**	Construction of Surface drainage (road or surface) where clearance cannot be maintained	No				No	No	No drainage will be constructed from land development across easement	*	*	6	#N/A			
2.15	**Both**	Washouts (construction phase) due to runoff diversions (surface drainage issue)	No		Site drainage plan	Possible easement damage	No	No	Temporary drains installed during construction phase and maintained until permanent drains installed	*	*	6	#N/A			
2.16	**Both**	Trench Excavation for drainage across easement to join site drainage in fill areas	No				No	No	None planned controlled within road reseerve.	*	*	6	#N/A			
2.17	**Both**	Retention pond excavation	No				No	No	Retention ponds planned outside of easement. No excavation within easement, slopes properly battered. See Threat 2.08	*	*	6	#N/A			
2.18	**Both**	Installation of power and lighting poles in proximity of the road crossing and parallel pipelines (issue vertical boring, and in the future maintenance replacement)	No				No	No	No service roads extend to the pipeline easement. Lighting associated with road crossings will be installed off-easement - or necessary to be installed maximise the distance from the pipe. Lighting design to be shown on detail construction drawings and be approved.	*	*	6	#N/A	Show lighting in road crossing designs to be submitted for approval	**21**	**Walker**
2.19	**Both**	Road Construction alongside a pipeline	No				No	No	Roads will be constructed parallel to the pipeline will not enter easement	*	*	6	#N/A			
2.20	**Both**	External loads from fill placement over pipeline imposes additional stress or subsidence	No				No	No	See Threats #15 & #16	*	*	6	#N/A			
2.21	**Both**	Unauthorised excavations at cuts that extend into the easement	Yes	Separation between pipe centre line and the easement boundary, pipeline wall thickness	Easement is marked by temporary fence. All workers informed of pipeline risks at induction and reinforced at regular safety meetings.	Easement damage	No	No	Fencing and site inductions, gas pipeline awareness etc provide primary controls	*	*	6	#N/A			

APA - Safety Management Study - Walker Development - Wilton South East Precinct

MSP	Diameter	864 mm	Steel Grade	X65 448 MPa Yield Stress	Critical Defect	141 mm		Hoop Stress at MAOP	72	% of SMYS				
	Wall Thickness	9.2	MAOP	**6.9 MPa**	Initiation Toughness			Hoop Stress at Operating Press.	40-70	% of SMYS				
	Measurement Length	665 m												
Ethane	Diameter	219.1 mm	Steel Grade	X60 414 MPa Yield Stress	Critical Defect	118 mm		Hoop Stress at MAOP	49.3	% of SMYS				
	Wall Thickness	8.1	MAOP	**14.895 MPa**	Initiation Toughness			Hoop Stress at Operating Press.	25-49.3	% of SMYS				
	Measurement Length	590 m						Pressure for hoop stress 30% SMYS	9.3	MPa				

Item	Pipeline	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
2.22	**Both**	Unauthorised excavations at cuts that extend into the easement causing damage to the easement surface	Yes	Damage is to the easement but not to the pipeline	Easement is marked by temporary fence. All workers informed of pipeline risks at induction and reinforced at regular safety meetings.	Easement damage	No	No	Fencing and site inductions, gas pipeline awareness etc provide primary controls	*	*	6	#N/A			
2.23	**Both**	Transformer earth fault with earth potential rise affecting pipeline	Yes		Transformers located within the lot. Council don't permit installation within road reserve.	Coating or pipeline metal loss	No	No	Transformers are relatively small and fault is not expected to affect the pipeline Electrical design to comply with AS 4853. Note that development power supplied from Bangara Gorge substation north of Picton Rd.	*	*	6	#N/A	APA review development electric power design Incorporate transformer impact assessment to AS 4853 in DCP	**22** **23**	**APA** **Walker**
2.24	**Both**	Stray current corrosion / coating damage	Yes		Cathodic protection management includes periodic testing to assess stray current corrosion sources		No	No	Sources of stray current are not expected to be installed as part of this development.	*	*	6	#N/A	APA to revise CP maintenance to reflect T1 maintenance provisions	**24**	**APA**
2.25	**Both**	Construction of sewer parallel and adjacent to easement	No	Centre line is 6m from the boundary at the north and 14m from the boundary at the south	APA procedures for access control, permit to work	No damage to the pipeline but easement may require reinstatement	No	No	Current design will drain sewage to a low point and transport to disposal using a pressure pipe. No construction within easemnet anticipated			#REF!	#N/A			
2.26	**Both**	Landscaping over the easement	Yes	Increased wall thickness and cover. Pipelines ~6 m from easement boundaries Slabbing			No	No		*	*	6	#N/A	Small equipment design provided to APA for approval, construction to APA procedures. Trees not permitted within the easement APA will maintain by periodic slashing to maintain line of sight.	**25**	**Walker**
2.27	**Both**		Yes				No	No		*		6	#N/A			
2.28	**Both**						No	No		*	*	6	#N/A			
2.29	**Both**		Yes				No	No		*	*	6	#N/A			
2.30	**Both**		Yes				No	No		*	*	6	#N/A			
2.31	**Both**		Yes				No	No		*	*	6	#N/A			
2.33	**Both**		Yes				No	No		*	*	6	#N/A			
										*	*	6	#N/A			
Phase 3 - Residential / CommercialConstruction										*	*	6	#N/A			
3.01	**Both**	External corrosion - stray currents associated with the operation of a Zone Substation constructed to serve all or part of the development	No				No	No		*	*	6	#N/A	T1 inspection procedures to be implemted. (6 month survey)	**As action #24**	**APA**
3.02	**Both**	Swimming pool construction and permanent structures on residential block in proximity to a pipeline - Easement instability	No	Pipeline cover Pipeline is not closer than 6 m from the easement boundary	APA patrols, including aerial patrols eachy7days expected to identify excavation close to easement boundary, enabling contact with landowner/constructor if required.	Partial collapse of the easement	No	No	Called "not credible" because lots are generally separated from the easement by a road	*	*	6	#N/A	This T1 section to be included in weekly patrols consistent with T1 obligationws	**26**	**APA**
3.03	**Both**	Driveways, fences, retaining wall construction on residential block potentially causing easement instability	No				No	No	Called "not credible" because lots are generally separated from the easement by a road	*	*	6	#N/A			
3.04	**Both**	Vertical boring for smaller structures. (Power poles not considered because these are part of the infrastructure development).	No				No	No	There are no roads close to the easement and no plans for installation of permanent lights near the easement	*	*	6	#N/A			
3.05	**Both**	External interference to the pipeline resulting from many subcontractors working on sites resulting in procedural controls being not effective	Yes			Easement damage leading to erosion	No	No	Each builder is required to provide a temporary fence to the site during construction of a residence (Statutory requirement).	*	*	6	#N/A	Consider mainting ATF during residential construction	**27**	**Walker / APA**
3.06	**Both**	External interference resulting from construction activities associated with the sensitive area (e.g. Vertical boring - fence and security arrangements for school etc.)	No				No	No	No sensitive areas	*	*	6	#N/A			
3.07	**Both**	Construction activities obstruct ROW preventing access to easement for pipeline maintenance	Yes		APA patrols, including aerial patrols each 7 days expected to identify excavation close to easement boundary, enabling contact with landowner/constructor if required.	Would delay emergency response if required	No	No		*	*	6	#N/A			
3.08	**Both**	Landowner (stakeholder) relationships harmed because pipeline maintenance activities damage residential assets	Yes		APA community relations procedures (when developed and implemented)		No	No	Managed through Land owner liaison	*	*	6	#N/A	Action - consider stakehlder management		**See Action #9**

APA - Safety Management Study - Walker Development - Wilton South East Precinct

MSP	Diameter	864 mm	Steel Grade	X65 448 MPa Yield Stress	Critical Defect	141 mm		Hoop Stress at MAOP	72	% of SMYS				
	Wall Thickness	9.2	MAOP	**6.9 MPa**	Initiation Toughness			Hoop Stress at Operating Press.	40-70	% of SMYS				
	Measurement Length	665 m												
Ethane	Diameter	219.1 mm	Steel Grade	X60 414 MPa Yield Stress	Critical Defect	118 mm		Hoop Stress at MAOP	49.3	% of SMYS				
	Wall Thickness	8.1	MAOP	**14.895 MPa**	Initiation Toughness			Hoop Stress at Operating Press.	25-49.3	% of SMYS				
	Measurement Length	590 m						Pressure for hoop stress 30% SMYS	9.3	MPa				

Item	Pipeline	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
3.09	**Both**	Horizontal Boring using smaller HDD machines for utility (gas, water, communication etc.) connection to houses with potential to contact the pipeline	No		See Sectioin 1		No	No	All such connections made from front of property	*	*	6	#N/A			
3.1	**Both**	Easement damage (landslip) resulting from inadequately stabilised batters in cut areas	No		Engineering design of earthworks and slope stabilisation batter		No	No	Batter slopes are low and not expected to be unstable. Closest pipeline is located at least 6 m from the easement boundary.	*	*	6	#N/A			
3.11	**Both**	Pipeline damage (displacement following landslip) resulting from inadequately stabilised batters in cut areas	No				No	No	Batter slopes are low and not expected to be unstable. Closest pipeline is located at least 6 m from the easement boundary.	*	*	6	#N/A			
3.12	**Both**	Erosion resulting from runoff concentrating at drains where fill is placed in existing gullies	Yes	Minimum cover at gullies is greater than minimum	APA patrols	Easement damage	No	No	The catchment is small and erosion from this threat, should it occur, is small	*	*	6	#N/A			
3.13	**Both**	Recreational access to the pipeline easement by the residents	Yes	Standard wall thickness and cover	APA patrols	Easement damage, Erosion Marker sign damage CP test point damage			Recreational access by residents is anticipated and may cause some wear and tear on the easement but is difficult to control - no impact is expected on the pipeline safety	*	*	6	#N/A	APA to consider S149 certificates to reference pipeline. Pipeline warning marker to APA standard for T1.	**28**	**APA**
3.14	**Both**									*	*	6	#N/A			
3.15	**Both**									*	*	6	#N/A			
3.16	**Both**									*	*	6	#N/A			
3.17	**Both**									*	*	6	#N/A			
3.18	**Both**									*	*	6	#N/A			
3.19	**Both**									*	*	6	#N/A			
3.2	**Both**									*	*	6	#N/A			
										*	*	6	#N/A			
										*	*	6	#N/A			
										*	*	6	#N/A			
Phase 4 - Residential										*	*	6	#N/A			
4.01	**Both**	External interference caused by activities associated with redevelopment, extensions, landscaping and similar activities	Yes	Increased wall thickness and cover. Pipelines ~6 m from easement boundaries Slabbing	Infrastructure development notification of APA for work done within XX m of the pipeline APA aerial patrols		No	No	Expected that these activities will be detected before there is an impact on the pipeline	*	*	6	#N/A			
4.02	**Both**	External interference threats associated with future consolidation of residential blocks to high density use	Yes	Increased wall thickness and cover. Pipelines ~6 m from easement boundaries Slabbing	Infrastructure development notification of APA for work done within XX m of the pipeline APA liaison with approval authority to identify changes to changes in land planning zones.		No	No	Currently the DCP will prohibit this form of development.	*	*	6	#N/A			
4.03	**Both**	Future land use change to convert residential areas to sensitive (e.g. retirement homes, community gathering areas)	Yes	Increased wall thickness and cover. Pipelines ~6 m from easement boundaries Slabbing	Infrastructure development notification of APA for work done within XX m of the pipeline APA liaison with approval authority to identify changes to changes in land planning zones.		No	No		*	*	6	#N/A	See above to include in DCP. Pursue developing MOU with council.	**29**	**Walker APA**
4.04	**Both**	Future expansion of a pipeline to incorporate looping or replacement of either pipeline.	Yes	As required by new design	New pipeline sections will comply fully with the requirements of AS2885		No	No	If this happens, a separate SMS will be undertaken to assess the safety of the new and the existing pipeline, and of risk to the community.	*	*	6	#N/A			
4.05	**Both**	Easement damage (landslip) resulting from inadequately stabilised batters in cut areas	Yes	Increased wall thickness and cover. Pipelines ~6 m from easement boundaries Slabbing			No	No	This threat is expected to be controlled by proper construction - see Threat #2.08	*	*	6	#N/A			
4.06	**Both**	Pipeline damage (displacement following landslip) resulting from inadequately stabilised batters in cut areas	Yes	Increased wall thickness and cover. Pipelines ~6 m from easement boundaries Slabbing			No	No	This threat is expected to be controlled by proper construction - see Threat #2.09	*	*	6	#N/A			
4.07	**Both**	Erosion resulting from runoff concentrating at drains where fill is placed in existing gullies	Yes	Minimum cover at gullies is greater than minimum			No	No	This threat is expected to be controlled by proper construction - see Threat #2.10	*	*	6	#N/A			
4.08	**Both**	Changed pipeline MAOP changes the "no rupture" status of the pipeline	Yes	To be determined	APA is required to comply with AS2885		No	No	If this happens, a separate SMS will be undertaken to assess the safety of the new and the existing pipeline, and of	*	*	6	#N/A			
4.09	**Both**	Poor easement maintenance results in a third party attempting to undertake maintenance without approval.	Yes	Increased wall thickness and cover. Pipelines ~6 m from easement boundaries Slabbing	Patrols, Signs, community liaison		No	No		*	*	6	#N/A			

APA - Safety Management Study - Walker Development - Wilton South East Precinct

MSP	Diameter	864 mm	Steel Grade	X65 448 MPa Yield Stress	Critical Defect	141 mm		Hoop Stress at MAOP	72	% of SMYS				
	Wall Thickness	9.2	MAOP	**6.9 MPa**	Initiation Toughness			Hoop Stress at Operating Press.	40-70	% of SMYS				
	Measurement Length	665 m												
Ethane	Diameter	219.1 mm	Steel Grade	X60 414 MPa Yield Stress	Critical Defect	118 mm		Hoop Stress at MAOP	49.3	% of SMYS				
	Wall Thickness	8.1	MAOP	**14.895 MPa**	Initiation Toughness			Hoop Stress at Operating Press.	25-49.3	% of SMYS				
	Measurement Length	590 m						Pressure for hoop stress 30% SMYS	9.3	MPa				

Item	Pipeline	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
4.1	Both	Federal Easement for both pipelines - special reqirements								*	*	6	#N/A	APA to review requirements for the easement and issue when road is transferrred to council. Pursue co use if required. Council crossing agreement	30	APA
										*	*	6	#N/A			
Risk - All Controls Fail										*	*	6	#N/A			
5.01	MSP	Undetected corrosion resulting in a 10 mm hole	Yes	Not effective	Not effective	Leak 0.13 GJ/s, radiation contours 24 and 14 m	Yes	Yes	Leak is relatively small, and given the pipeline location, the plume is expected to be dispersed to < LFL before it reaches a source of ignition. Since gas is odourised, the leak is expected to be identified and reported by smell - also there will be some noise. Chance of ignition is very low	Hypothetical	Minor	5	Negligible			
5.02	Ethane	Undetected corrosion resulting in a 10 mm hole. Pressure assumed at 15MPa	Yes	Not effective	Not effective	Leak 0.4 GJ/s, 4.7 kW/m2 radiation contours 40 m. See calculation worksheet	Yes	Yes		Hypothetical	Severe	4	Negligible			
5.03	Both	Pipeline puncture by some device resulting in a 30 mm hole (1 GJ/s energy release)	Yes	Not effective	Not effective	MSP Leak 3 GJ/s, 4.7 kW/m2 radiation contour 112 Ethane leak 3.7 GJ/s, 4.7 kW/m2 radiation contour 128 m	Yes	Yes	There are no activities identified along the easement that could cause this damage. It is assessed as an all controls fail event.	Hypothetical	Major	3	Low	for the ethane pipeline the consequence may be greater because of cold, dense gas		
5.04	MSP	Pipeline puncture by some an HDD resulting in a hole about 75 mm equivalent diameter resulting in an energy release rate of about 8 GJ/s	Yes	Not effective	Not effective	MSP Leak 8.2 GJ/s, 4.7 kW'm2 radiation contour 185 and 12.6 kW/m2 contour = 115 m	Yes	Yes	The dial before you dig would normally identify the pipeline and result in discussion with APA, and their procedures implemented. This threat borders on not-credible following the construction phase because there is insufficient room for the equipment to be set up. The threat is credible on Picton Road and on the south side of the development.	Hypothetical	Catastrophic	2	Intermediate	This threat is largely controlled by installing the services at road crossings and providing spare capacity at these crossings. The severity may be major because the easement is bounded by roads which extend the separation from pipeline to property boundary. This threat exists along the whole pipeline, and is seemingly less likely in this development than in more rural locations simply because of the additional controls associated with ground opening in a residential development than in rural areas. Further assessment by ALARP processes will not change the risk for this pipeline. The threat will be controlled by management procedures developed by APA for this threat in other areas of the pipeline.		
5.05	Ethane	Pipeline puncture by some an HDD resulting in a hole about 75 mm equivalent diameter resulting in an energy release rate of about 8 GJ/s	Yes	Not effective	Not effective	Leak 27.4 GJ/s, radiation contour 340 m	Yes	Yes	The dial before you dig would normally identify the pipeline and result in discussion with APA, and their procedures implemented. It is probable that the drill bit will deflect above or beneath the pipeline, because of the small pipeline diameter. This threat borders on not-credible following the construction phase because there is insufficient room for the equipment to be set up. The threat is credible on Picton Road and on the south side of the development.	Hypothetical	Catastrophic	2	Intermediate	This threat is largely controlled by installing the services at road crossings and providing spare capacity at these crossings. This flow will rapidly diminish as the pseudo liquid is discharged causing pressure and temperature to fall but assess as the maximum flow value. The threat exists for this pipeline in residential areas through to the end of the pipeline and except where the pipeline is installed in the rail corridor, the threat (HDD) is an accepted residual risk. Further assessment by ALARP processes will not change the risk for this pipeline. The threat will be controlled by management procedures developed by APA for this threat in other areas of the pipeline.		
5.06										*	*	6	#N/A			
ALARP Assessment Land Use Change										*	*	6	#N/A			
					ALARP Alternative	Risk Reduction	Cost		Comment							

APA - Safety Management Study - Walker Development - Wilton South East Precinct

	MSP	Diameter	864 mm	Steel Grade	X65 448 MPa Yield Stress	Critical Defect	141 mm		Hoop Stress at MAOP	72	% of SMYS				
		Wall Thickness	9.2	MAOP	**6.9 MPa**	Initiation Toughness			Hoop Stress at Operating Press.	40-70	% of SMYS				
		Measurement Length	665 m												
	Ethane	Diameter	219.1 mm	Steel Grade	X60 414 MPa Yield Stress	Critical Defect	118 mm		Hoop Stress at MAOP	49.3	% of SMYS				
		Wall Thickness	8.1	MAOP	**14.895 MPa**	Initiation Toughness			Hoop Stress at Operating Press.	25-49.3	% of SMYS				
		Measurement Length	590 m						Pressure for hoop stress 30% SMYS	9.3	MPa				

Item	Pipeline	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
6.01	MSP		Yes		MAOP Reduction	Currently complies with no rupture. Minor reduction in consequence of a leak as a result of reduced flow rate.			Existing pipe complies with high consequence provisions at current operating pressure. Will change if technically feasible to raise pressure to MAOP							
	Ethane		Yes		MAOP Reduction	Comply with no rupture - Leak only. Minor reduction			Pressure reduction to 12 MPa needed to classify pipe as "No Rupture" (CDL 150-160 mm). May limit pipeline capacity. Pressure margin needed to keep "liquid" phase	*	*	6	#N/A			
6.02	MSP		Yes		Pipe Replacement with No Rupture Pipe	Eliminated	Cost to replace is in the order of $8-10 million.		Existing pipe in Bangara Gorge T1 area accepted with external interference protection.	*	*	6	#N/A	Not required		
	Ethane		Yes		Pipe Replacement with No Rupture Pipe	Eliminated	Cost to replace is in the order of $2-4 million.		Existing pipe in Bangara Gorge T1 area accepted with external interference protection. Existing pipe considered to practically comply with high consequence area requirements	*	*	6	#N/A			
6.03	MSP		Yes		Pipeline relocation	Eliminated	Probable cost $15-18 million		Approx 6 km - Would also solve proposed rail.	*	*	6	#N/A	Acess through the water catchment area would be very difficult to obtain. Considered Impractical		
	Ethane		Yes		Pipeline relocation	Eliminated	Probable cost $4-6 million		Approx 6 km.	*	*	6	#N/A	Acess through the water catchment area would be very difficult to obtain. Considered Impractical		
6.04	MSP		Yes		Modify Land Use	N/A			Impractical because measurement length ~600 m							
	Ethane		Yes		Modify Land Use	N/A			Impractical because measurement length ~600 m	*	*	6	#N/A			
6.05	MSP		Yes		Control by Physical & Procedural Methods	Severity reduced to comply with high consequence area provisions	$1.57 million		Approx 1270m south of Picton Rd and 125 m north, less road crossings (approx 100 m) @$1210/m = $1.57 million	*	*	6	#N/A			
	Ethane		Yes		Control by Physical & Procedural Methods	Severity reduced to comply with high consequence area provisions	$1.06 million		Approx 750m south of Picton Rd and 125 m north, less road crossings (approx 100 m) @$1210/m = $1.06 million	*	*	6	#N/A			
			Yes							*	*	6	#N/A			

APPENDIX 3

Attendee Register

APA - Safety Management Study - Walker Development - Wilton South East Precinct

10:00 August 24, 2017

Picton Bowling Club, 11 Cliffe St Picton

SMS Workshop – Design Authorisation Stage

ATTENDEE LIST			
Name	**Organisation**	**Representing which Discipline or Project Interest**	**Signature**
Phil Venton	Venton & Associates	Facilitator	
Stuart Gander	Walker corporation	Development	
ROSS LARSEN	APA	Gas pipeline	
CARMELA PELAEZ	BG&E	CIVIL ENGINEERING DESIGN	
Martin Wong	APA	Mech Eng	
SEAN BROKMAN	APA	GAS PIPELINE	
MARK WALKER	Delos / Goodsor	Ethane Pipeline	
CHRIS MEADES	APA.	PIPELINE OPERATIONS.	