9 Hazard and risk

This chapter summarises the addendum to the GGP PHA prepared by Planager Pty Limited (Planager) which is provided in full in Appendix F. It was prepared with reference to the original GGP PHA prepared by Sherpa as part of the AECOM (2009a) EA.

9.1 Existing environment

Land use in the vicinity of the proposed pipeline corridor realignments is described in Section 2.1. It includes rural, residential and industrial land uses. Parts of the Seaham, Millers Forest and Tomago sections are adjacent to and/or cross under electricity transmission lines. The southern end of the modified pipeline corridor is within an approximately 30 m wide easement that contains AGL's Tomago to Hexham high pressure gas transmission pipeline. The corridor ends at the TRS, within an industrial area adjacent to the NGSF.

Most residences in the surrounding areas are further from the proposed modified pipeline corridor than the approved route. The 2009 PHA identified the nearest residences to be approximately 15 to 40 m from the approved alignment. Aerial photography analysis identified that residences are typically more than 200 m from the modified pipeline corridor alignment, though a small number are around 40 to 50 m from its centreline. The closest sensitive receptors to the corridor are identified in Table 8.5, along with approximate offset distances from its centreline.

9.2 Impact assessment

9.2.1 Assessment method

i Overview

The original AECOM (2009a) EA for the approved GGP included a PHA by Sherpa. The method for hazard and risk analysis is well established in Australia, and was detailed in the Sherpa (2009) PHA. The original PHA evaluated hazards and risks of the GGP's facilities, including the gas transmission pipeline and HDS. It included quantitative estimates of consequences and likelihoods of incident scenarios. The PHA was undertaken in accordance with the following Hazardous Industry Planning Advisory Papers (HIPAPs) and guidelines:

- *HIPAP No. 6 Guidelines for Hazard Analysis* (DP&I 2011a);
- *HIPAP No. 4 Risk Criteria for Land Use Safety Planning* (DP&I 2011b); and
- *Multi Level Risk Assessment* (DP&I 2011c).

These guidelines were updated in 2011 however the changes did not affect the methodology or criteria for risk assessment. Hence there was no requirement for the addendum PHA to consider any different methodology or criteria from those used in the 2009 PHA.

The types of risks considered are risk of acute human injury or fatality. This is expressed as individual risk of fatality and injury and as risk of propagation (or escalation), as per the DP&I (2011a) HIPAP No. 6 guidelines. The 2009 PHA identified potential hazards associated with the gas transmission pipeline and HDS. It evaluated the potential for a loss of containment of natural gas, followed by ignition and fire. These potential hazards are valid also for the proposed modified sections of pipeline and TRS. The safeguards to prevent, minimise, control and mitigate against potential hazardous incidents are also identified in the 2009 PHA and apply to the proposed modification.

ii Approach

The approach taken for the addendum PHA was to systematically assess the proposed modification against the design and operational specifications assumed for the approved pipeline corridor alignment and HDS in the original PHA. This was to evaluate whether the proposed modification would influence the results of the original hazard and risk assessment, or whether the design basis has remained intact and the conclusions made remain valid. The review included the following steps:

1. Identify changes made to the design and layout of the pipeline and TRS, and any changes to safeguards or systems that may influence the assumptions or conclusions made in the original PHA.

2. Assess the proposed modification to determine whether it will result in an increase (worsening) or a decrease (amelioration) of hazards and risks identified in the original PHA.

3. Consider any requirement to update the risk contour figures.

4. Identify any changes or additions to the design, safety controls and management measures, as detailed in the PHA, which are required to manage the potential hazards and risks.

5. Identify any changes or additional recommendations to those in the original PHA. It is noted that the approved GGP has conditions of Project approval relating to hazard and risk that require further comprehensive studies at various stages of the GGP, including a Final Hazard Analysis (FHA).

Given that the proposed pipeline and TRS construction and operating activities are unchanged from those described in the AECOM (2009) EA for the approved pipeline and HDS, the focus was on whether the minor change to the location of activities in the Seaham, Brandy Hill, Millers Forest and Tomago sections and at the TRS would result in any change to outcomes of the 2009 assessment.

9.2.2 Modified pipeline corridor alignment

i Overview

The original PHA set out assumptions relating to engineering specifications of the pipeline. These include assumptions regarding pipeline diameter, thickness, flow rates, operating temperature, operating pressure and burial depth. The proposed modification will not change these assumptions, which are detailed in Appendix F.

The original PHA assessed several possible design scenarios or ‘cases’ for the pipeline, taking into account a range of design parameters and safeguards in terms of pipeline diameter (DN 450/250), location class (being either Rural (R1) or Residential (T1) land as defined in AS 2885.1), depth of cover (DOC), wall thickness (WT) and presence or absence of marker tape. All these cases have been assessed for the proposed modification, and are listed in Table 9.1.

The 2009 PHA produced risk transects for each of these cases, which identified the minimum separation distances required from the pipeline's centreline to various land use types to ensure compliance with the risk criteria defined in the HIPAP 4 guidelines. These minimum separation distances are provided in Table 9.1 for ease of reference.

The proposed modification does not change the construction or operating assumptions applied in the 2009 PHA. Therefore the calculated buffer distances in Table 9.1 also apply to the proposed realigned sections of pipeline and have been used in this EA. No further consequence or risk analysis is required in respect of the proposed modification at this PHA stage.

Table 9.1 PHA results – pipeline design cases

Pipeline diameter	Case	Design feature	Distance to individual risk of fatality[3] (m)				
			Sensitive[1] 0.5×10^{-6} year	Residential 1×10^{-6} year	Commercial 5×10^{-6} year	Active open space 10×10^{-6} year	Industrial 50×10^{-6} year
DN450	1	R1, 750 mm DOC, 11 mm WT, no marker tape	190	35	Not reached	Not reached	Not reached
	2	T1, 900 mm DOC, 11 mm WT[2], marker tape	41	Not reached	Not reached	Not reached	Not reached
DN250	3	R1, 750 mm DOC, 5 mm WT, no marker tape	230	215	20	Not reached	Not reached
	4	T1, 900 mm DOC, 12.7 mm WT[2], marker tape	35	Not reached	Not reached	Not reached	Not reached
	5	Road/rail crossings, 1,200 mm DOC, 7.5 mm WT, marker tape	43	Not reached	Not reached	Not reached	Not reached
	6	Intermediate watercourses, 1,500 mm DOC, 7.5 mm WT, no marker tape	45	12	Not reached	Not reached	Not reached
	7	Major watercourses, 2,000 mm DOC, 7.5 mm WT, no marker tape	10	Not reached	Not reached	Not reached	Not reached

Notes: *1. For example hospital or nursing home.*

2. The pipeline will satisfy AS 2885.1 design specifications for pipelines in T1 locations, including minimum WT, such that failure by rupture will not occur and the maximum energy release rate from the failure will not exceed 10 GJ/s.

3. The risk criteria are for the 'individual risk of fatality', expressed as probability per annum. For example, the risk level criteria for residential land uses is 1×10^{-6} per year, assuming 24 hour exposure to the risk, with no allowance for the protection buildings may offer or for the potential to move away (escape) from a developing incident.

Source: *Sherpa (2009).*

Table 9.1 shows that risk levels applicable to most land uses were not reached for most design scenarios assessed. Buffer distances up to 230 m were required from sensitive land uses, such as hospitals, however no such land uses were identified within 230 m of the proposed pipeline.

For the DN 250 pipeline in R1 locations assuming 750 mm depth of cover, 5 mm wall thickness and no marker tape (Case 3), risk levels with the potential for significant impact to residential areas (1×10^{-6} per year) were shown to extend up to 215 m from the pipeline's centreline, with shorter distances of 12 and 35 m for Cases 6 and 1 respectively. The 2009 PHA identified the nearest residences to be as close as 15 m from the approved pipeline corridor. Therefore, at these locations, close to residential land uses, Cases 1 and 3 (with 750 mm DOC and no marker tape) will not comply with the DP&I's risk criteria and additional measures will be required at these locations, such as additional depth of cover and/or marker tape.

The following sections evaluate any changes to hazards and risk as a result of the proposed modification. Minimum separation distances to various land uses are provided and any pipeline design cases which would not comply with the DP&I's risk criteria are identified.

ii Seaham section

Changes under the proposed modification and associated changes to hazards and risks are described in Table 9.2 for the Seaham section.

Table 9.2 Changes to hazards and risks for the Seaham section

Change under the proposed modification	Change in risk	Mitigation measures
Reduction in pipeline length at this section from about 690 m to about 650 m.	The reduction in pipeline length results in a net reduction in the overall risk associated with this section of the pipeline.	No additional measures required.
Reduction in the buffer distance between the pipeline and some residences to the north (the closest of which is the AGL-owned dwelling around 45 m from the corridor's centreline). No residences were identified closer than those considered in the 2009 assessment.	DN250 Case 3 is not acceptable for parts of the Seaham section as the minimum required buffer distance from the pipeline's centreline to residential dwellings is 215 m, ie larger than the actual distance between the pipeline and the closest dwellings. If the final siting of the pipeline within the corridor is within the 35 m of the closest residence, DN450 Case 1 would also not be acceptable at this location. These restrictions also apply for other locations along the approved pipeline corridor. All other relevant design cases in Table 9.1 are acceptable.	No additional measures required. Design Case 3 and potentially Case 1 would not be suitable for parts of the pipeline within the Seaham section.
Similar to the approved alignment, the pipeline will be constructed within and adjacent to a transmission line easement.	This does not introduce any new hazards or require any new safeguards not previously identified and discussed in the 2009 PHA.	No additional measures required.
No additional land uses would be affected by the change in alignment within the Seaham section.	N/A no other land uses would be affected by the proposed modification.	No additional measures required.
MLV facility within this section.	Not previously assessed, however the risk is assessed as acceptable based on buffer distances between the MLV and surrounding land uses.	As required under the Project approval, the FHA of the GGP will provide a quantitative evaluation of the risk associated with the MLV.

The original PHA did not assess the proposed MLV facility in detail. However, due to the simple and robust design of such a valve site and the stringent requirements for this type of facility, as specified in the relevant codes and standards, including AS 2885, the hazards and risks are expected to be very low and similar to those for the pipeline. The required buffer distances to adjacent land uses are therefore expected to be similar, if somewhat marginally increased, compared with those evaluated for the approved pipeline in the original PHA. The buffer distance to residential land use is expected to comply with the stringent risk criteria in NSW. However, it is recommended that the FHA of the GGP, required by the existing Project approval conditions, provide a quantitative evaluation of risk associated with the MLV facility, once its detailed design has been developed.

iii Brandy Hill section

Changes under the proposed modification and associated changes to hazards and risks are described in Table 9.3 for the Brandy Hill section.

Table 9.3 Changes to hazards and risks for the Brandy Hill section

Change under the proposed modification	Change in risk	Mitigation measures
Increased buffer distance (generally more than 335 m increase) between the pipeline and most residences. Reduced buffer distance between the pipeline and one residence near the northern end of the Brandy Hill section (expected to be around 30 to 50m from the pipeline). No residences were identified closer than those considered in the 2009 assessment.	Increased buffer distance to several surrounding residences results in a net reduction in risk at these dwellings. DN250 Case 3 is not acceptable at the northern and southern ends of the Brandy Hill section as the minimum required buffer distance from the pipeline's centreline to residential dwellings is 215 m. DN450 Case 1 may not be acceptable at the northern end, depending on whether the final pipeline alignment within the 100 m wide corridor is within 35 m of the nearest residence. These restrictions also apply for other locations along the approved pipeline corridor. All other relevant design cases in Table 9.1 are acceptable.	No additional measures required. Design Case 3, and potentially Case 1, would not be suitable for part of the pipeline within the Brandy Hill section.
No additional land uses would be affected by the change in alignment within the Brandy Hill section.	N/A no other land uses would be affected by the proposed modification.	No additional measures required.

iv Millers Forest section

Changes under the proposed modification and associated changes to hazards and risks are described in Table 9.4 for the Millers Forest section.

Table 9.4 Changes to hazards and risks for the Millers Forest section

Change under the proposed modification	Change in risk	Mitigation measures
Increased buffer distance between the pipeline and residences to the west, but reduced in buffer distances to the east. The pipeline is expected to be around 30 to 50m from the closest residence. No residences were identified closer than those considered in the 2009 assessment.	Increased buffer distances between the pipeline and several surrounding residences results in a net reduction in risk at these dwellings. DN250 Case 3 is not acceptable at parts of the Millers Forest within 215 m of dwellings. DN450 Case 1 may not be acceptable at the northern end, depending on whether the final pipeline alignment within the 100 m wide corridor is within 35 m of the nearest residence. These restrictions also apply for other locations along the approved pipeline corridor. All other relevant design cases in Table 9.1 are acceptable.	No additional measures required. Design Case 3, and potentially Case 1, would not be suitable for parts of the pipeline within the Millers Forest section.
The pipeline will be constructed within and adjacent to a transmission line easement.	This does not introduce any new hazards or require any new safeguards not previously identified and discussed in the PHA.	No additional measures required.

v Tomago section

Changes under the proposed modification and associated changes to hazards and risks are described in Table 9.5 for the Tomago section.

Table 9.5 Changes to hazards and risks for the Tomago section

Change under the proposed modification	Change in risk	Mitigation measures
Increased buffer distance between the pipeline and industrial and commercial land uses at Hexham and some at Tomago.	The increased in buffer distances results in a net reduction in risk at these locations.	No additional measures required.
Reduced buffer distances to some industrial land uses at Tomago and open space at the Hunter Region Botanic Gardens.	No significant change to risk levels. The buffer distance from residential, commercial, open space and industrial land uses is such that all relevant design cases in Table 9.1 are acceptable for the Tomago section.	No additional measures required.
A reduction in crossings of the Hunter River.	The risk associated with the single crossing of the Hunter River would reduce compared to two crossings for the approved pipeline.	No additional measures required.

Table 9.5 Changes to hazards and risks for the Tomago section

Change under the proposed modification	Change in risk	Mitigation measures
At the approach to the TRS and NGSF, the pipeline will be within the same pipeline corridor as an existing high pressure gas transmission pipeline.	Co-location of the pipeline in the same corridor as the existing high pressure pipeline introduces a theoretical (though highly improbable) potential for a domino incident from one pipeline to the other. Preventative and protective features for this potential hazard are specified in AS 2885.1 and relate to: • internal risk management procedures/systems by the pipeline operator; • pipeline integrity plans (including systems to monitor integrity of the pipeline and coating inspection); • thickness and grade of the pipelines; • both pipelines buried at a depth of at least 750 mm (450 mm in rock); and • natural gas disperses readily upwards. As determined in the 2009 PHA, the likelihood of ignition and explosion is highly unlikely in an unconfined situation such as for this section of the pipeline.	The detailed design and construction of the modified pipeline where it is co-located with AGL's existing high pressure pipeline, should ensure the risk of a potential domino incident from one pipeline to the other is minimised. The FHA will provide a quantitative evaluation of the risk.
Some sections of the pipeline are adjacent to and cross transmission line easements.	This does not introduce any new hazards or require any new safeguards not previously identified and discussed in the PHA.	No additional measures required.

9.2.3 TRS and odourant facility

The original PHA considered hazards and risks associated with the HDS at Hexham. The assumptions for the HDS are relevant to the proposed TRS. Key assumptions are provided in Appendix F and relate to the processing equipment, operating pressures, flow rates, design temperatures and provision of an odourant facility. The proposed modification will not result in changes to these assumptions, except the proposed location of these facilities at Tomago rather than Hexham.

The 2009 PHA produced risk contours for the HDS which identified the minimum separation distances required from the HDS to various land uses to ensure compliance with risk criteria defined in the HIPAP guidelines. These calculations remain applicable for the TRS and are reproduced in Table 9.6.

Table 9.6 PHA results – HDS/TRS risk profile

Distance to individual risk of fatality (m)					Risk of propagation (escalation)	Injury risk
Sensitive (eg hospital) 0.5 x 10^{-6} year	**Residential 1 x 10^{-6} year**	**Commercial 5 x 10^{-6} year**	**Active open space 10 x 10^{-6} year**	**Industrial 50 x 10^{-6} year**	**Neighbouring industry 50 x 10^{-6} year**	**Residential and sensitive 50 x 10^{-6} year**
30	20	Contained within site boundary	Not reached	Not reached	Not reached	Not reached

Source: Sherpa (2009).

The TRS will be within an industrial area, in which there are no sensitive, residential or commercial land uses. This is the same as the situation evaluated in the PHA for the HDS at the Hexham industrial area. The risk contours for sensitive land use and residential areas extend off-site by a maximum of 30 m. The actual buffer between the TRS and such development is much larger (more than 1.5 km). The risk levels for other land use types (open spaces and industrial) were not generated for the site; the buffers were larger than for residential areas and not reached.

The original PHA demonstrated that the risk level relevant for escalation (accident propagation) from the HDS was not reached. Therefore the risk of propagation of an incident at the TRS to the adjacent NGSF is negligible. Similarly, the FHA prepared for the NGSF (Planager 2013) shows that the propagation risk contour from the NGSF does not extend to the proposed location of the TRS. Therefore the risk of propagation of an incident at the NGSF to the TRS is also negligible.

The 2009 PHA stated that odourant was to be injected into the sales gas, however, no further discussion was provided on the odourant facility. The odourant facility's design is still in its preliminary stage. The addendum PHA assessed both options for its location, that is within the TRS (Option 1) or within the adjacent NGSF compound (Option 2).

The odourant facility will include pressurised vessels containing the gas odourant mercaptan. For Option 1, the total volume would be two vessels each weighing 850 kg. For Option 2, the total volume of odourant on the NGSF site would be double that of Option 1, to allow for the volume required for AGL's existing high pressure pipeline.

For both options, the vessels would be in a bunded area inside a closed building which would be mechanically ventilated through a carbon filter or adsorber. The vessels would be delivered to site, moved off the truck and transported into place. No liquid unloading operation would take place. The odourant would be pumped or pushed out of the storage vessel using a slight overpressure of natural gas and injected into the natural gas stream via a fixed stainless steel line.

Any excess dosing of odourant into the natural gas stream is expected to be a gas quality issue only and is likely to be identified through periodic gas checks. Under-dosing will be prevented by monitoring levels in the vessels as well as manual checks. Once the line has been in use for some time, the odourant contamination of the piping is such that the gas would continue to be odourised for some time after cessation of dosing.

The odourant, mercaptan, is a flammable liquid with properties similar to petrol. The requirements for fire risk management of the relatively small quantities of odourant will comply with the relevant Australian standard (currently AS 1940: Storage and handling of flammable and combustible liquids) including:

- bunding requirements;
- fire protection, including fire extinguishers, hose reel requirements and separation distances;
- design of ventilation of enclosure with regards to flammable vapours;
- valving and piping associated with the storage; and
- control of ignition sources.

Provided the requirements of AS 1940 are adhered to, the probability of a fire involving odourant is negligible for both options.

When released, odourant is a colourless malodorous gas. In the event of spillage, unless contained, the odour could extend considerable distances at detectable odour levels, adversely affecting amenity. To manage this risk, vessels would be enclosed in a building which is ventilated to a scrubber or an adsorber in order to remove unpleasant odours in the event of a loss of containment inside the building. By eliminating the need for liquid unloading and placing the odourant vessels inside a ventilated building ensures that the risk of a release of malodorous mercaptan to the atmosphere is minimised.

9.3 Management and monitoring

The safeguards to prevent, minimise, control and mitigate against potential hazardous incidents are identified in the Sherpa (2009) PHA and apply to the proposed modification.

The risk associated with the odourant facility is negligible. Provided the requirements of AS 1940 are adhered to, the probability of a fire involving the odourant facility is negligible for both options for its location.

The co-location of the pipeline in the same corridor as AGL's Tomago to Hexham pipeline for part of the Tomago sections is an additional risk of the proposed modification compared to the approved pipeline. The co-location of the two pipelines introduces the theoretical potential for a domino incident from one pipeline to the other, however this is highly improbable. The preventative and protective features for hazards associated with the co-location of pipelines include:

- internal risk management procedures/systems by the pipeline operator/s;
- pipeline integrity plans (including systems to monitor integrity of the pipeline and coating inspection);
- thickness and grade of the pipelines; and
- pipeline burial depth of at least 750 mm (450 mm in rock).

The detailed design and construction of the pipeline in the Tomago section where it is co-located with the AGL's existing high pressure pipeline should ensure the risk of a potential domino incident from one pipeline to the other is minimised. The residual risk will be reported in the FHA for the GGP, as required under Condition 3.47 of the Project approval. The FHA will also address the MLV facility.

Other requirements in the Project approval conditions relating to hazard and risk include a fire safety study, construction safety study, hazard audit and an OEMP that includes hazard and safety and emergency management measures (Conditions 3.47, 4.10 and 7.4). These are also considered appropriate for the proposed modified elements of the GGP.

The proposed modification does not warrant changes or additions to the design and safety controls, management measures and recommendations identified and discussed in the original PHA and those included in the Project approval.

9.4 Conclusions

The addendum to the PHA (Appendix F) has confirmed the conclusions in the original PHA (Sherpa 2009), that the proposed modification does not introduce undue risk to surrounding land uses. The proposed modification does not any new hazards or risks or result in any unacceptable risks. The design and safety controls and management measures identified in the original PHA and the Project approval conditions remain largely unchanged.