Appendix E

Noise and Vibration Assessment

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Minor Pipeline Corridor Realignments Environmental Assessment

Noise and vibration assessment

Prepared for AGL Upstream Infrastructure Investments Pty Limited | 12 November 2013

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Noise and vibration assessment

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1 Introduction

1.1 Background

AGL Upstream Infrastructure Investments Pty Limited (AGL) has Commonwealth and State government approval to construct and operate the Gloucester Gas Project (GGP) in the Hunter region of NSW. One component of the GGP is an approximately 95 to 100 km long high pressure gas transmission pipeline from a central processing facility (CPF) at Stratford to a gas delivery station at Hexham. The approved GGP is described and assessed in detail in the AECOM (2009) *Gloucester Gas Project Environmental Assessment*, inclusive of a comprehensive noise and vibration assessment by Atkins Acoustic and Associates Pty Ltd (Atkins).

AGL proposes to realign four sections of its proposed pipeline corridor and connect it into its approved Newcastle Gas Storage Facility (NGSF) at Tomago, rather than the Hexham Delivery Station (HDS). End of pipeline facilities are proposed within a compound at the NGSF connection point, referred to as the Tomago Receiving Station (TRS). The proposed TRS facilities are similar to those previously assessed and approved for the HDS, which is no longer proposed. The minor realignments are to further minimise vegetation clearing and other environmental impacts, avoid recently-constructed utilities, achieve economic and efficiency benefits, and allow the connection with the NGSF.

EMGA Mitchell McLennan Pty Limited (EMM) has been engaged by AGL to prepare an Environmental Assessment (EA) of the proposed modification, including a noise and vibration assessment. This noise and vibration assessment has been completed in accordance with relevant guidelines and standards and with consideration to the relevant Director-General's requirements previously issued for the GGP. It takes into consideration the methodology and outcomes of the Atkins (2009) *Operation and Construction Noise Assessment - Gloucester Gas Project*. This report documents the assessment methodology and results, including comparison with results of the original 2009 assessments of the approved pipeline corridor alignment and HDS. It also identifies mitigation and management measures, including referencing commitments from the original AECOM (2009) EA and approval conditions, which will also be applied to the modified elements where relevant.

A number of technical terms are used for the discussion of noise and vibration in this report. These are explained in Appendix A.

1.2 Overview of the proposed modification

The proposed modification is for four minor pipeline corridor realignments and connection to the NGSF via the TRS. Figure 1.1 shows the approved and proposed modified pipeline corridor alignments. The realigned sections are referred to as the Seaham, Brandy Hill, Millers Forest and Tomago sections as follows:

- Seaham section (Figure 1.2) – an approximately 0.65 km long section of pipeline corridor at East Seaham, proposed to be straightened and realigned up to 100 m north, to be mostly within a cleared area within and adjacent to a TransGrid transmission line easement.

- Brandy Hill section (Figure 1.3) – an approximately 5 km long section of pipeline corridor near Brandy Hill, proposed to be straightened and realigned generally up to 335 m west. The proposed realignment is further from sensitive receptors at Brandy Hill.

- Millers Forest section (Figure 1.4) – an approximately 2.5 km long section of pipeline corridor at Millers Forest, proposed to be realigned around 50 m east, to avoid the recently-constructed Transgrid transmission line.

- Tomago section (Figure 1.5) – an approximately 6.5 km long section of the pipeline corridor's southern end, proposed to be realigned to connect with the NGSF at Tomago (rather than the HDS). The proposed realignment avoids a wetland area, reduces disturbance to acid sulphate soils and only involves one crossing of the Hunter River (rather than the two crossings approved). Consistent with the approved pipeline, the river crossing is proposed to be by horizontal directional drilling (HDD).

The realigned sections of pipeline corridor generally traverse rural and semi-rural landscapes and cleared utility and access track corridors. Consistent with the approved project it crosses roads, waterways and drainage lines. There are rural and semi-rural residences in the surrounding area, as well as some urban areas, however the realigned sections of pipeline corridor are further from most of them than the approved route. The pipeline culminates at the proposed TRS, at the NGSF, which is within an existing industrial area (Figure 1.5).

The proposed TRS is similar to the previously assessed and approved HDS. It will be in place of the HDS, which is no longer proposed. The TRS is proposed to be constructed and operated at the location shown on Figure 1.5, adjacent to the NGSF, in the Tomago industrial area. Facilities will include a control room, water bath heater access pad, filters, water bath heaters, attenuator, pig receiver, regulators, valve and meter skids and odourant facility. Two options are being considered for the odourant facility's location, only one of which will be adopted:

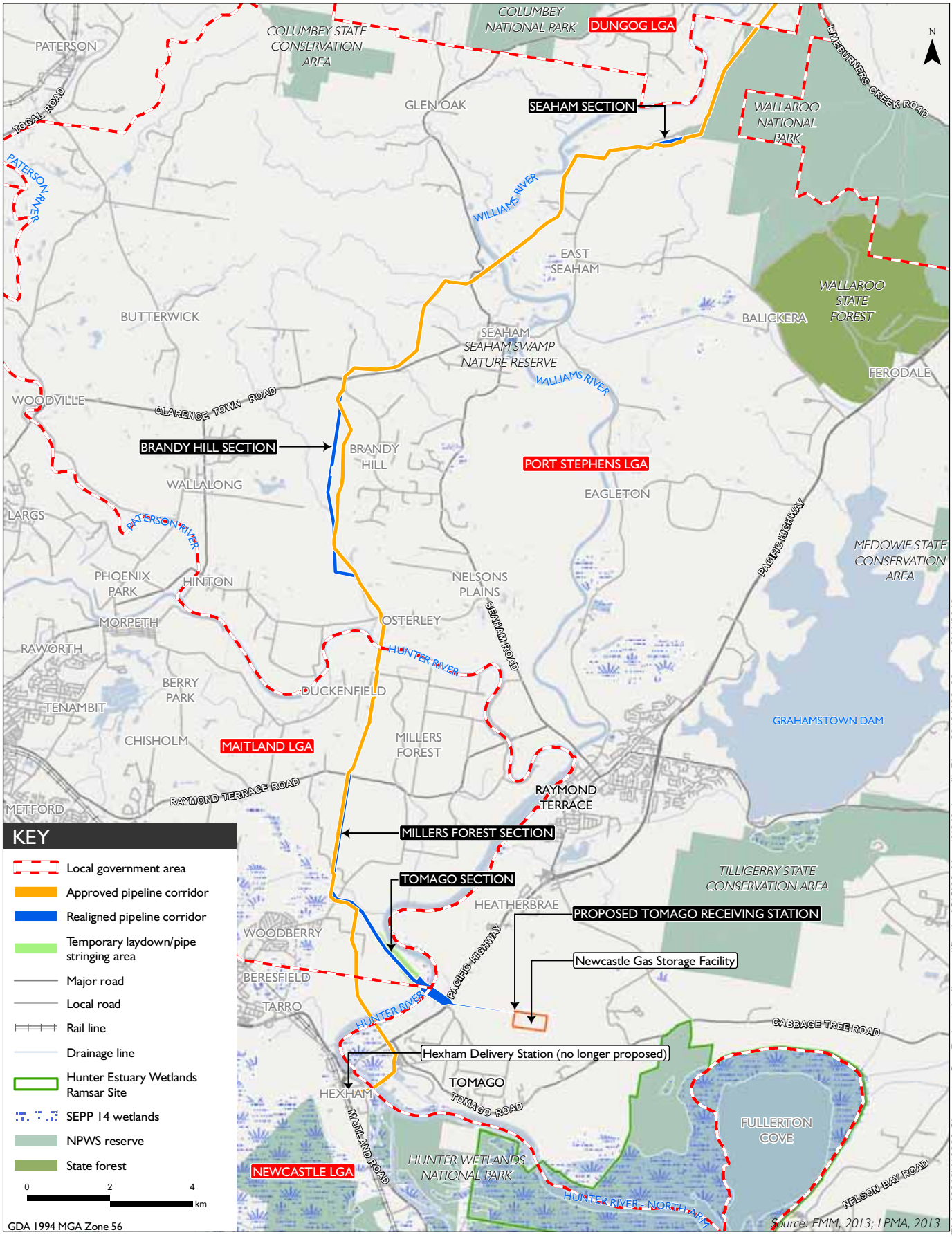
- Option 1 - within the TRS, adjacent to the NGSF compound; or

- Option 2 - within the NGSF compound.

The odourant facility location will be confirmed during its detailed design. This assessment has considered both options.

The proposed pipeline construction and operating activities are unchanged from those described in the AECOM (2009) EA for the original (approved) pipeline route. In summary, the pipeline will mostly be constructed by open trenching, though some sections will be by thrust boring or HDD. The Seaham section will include a main line valve (MLV) (refer to Figure 1.2) which will be the same as that described in the AECOM (2009) EA, and which formed part of the approved project. While the AECOM (2009) EA identified that an MLV would be required, approximately half way along the pipeline, and it was approved, further detail on its potential location was not available at that stage. The current preferred location has since been identified to be within the Seaham section, and it has been considered accordingly in this assessment. The exact location and design will be confirmed during its detailed design.

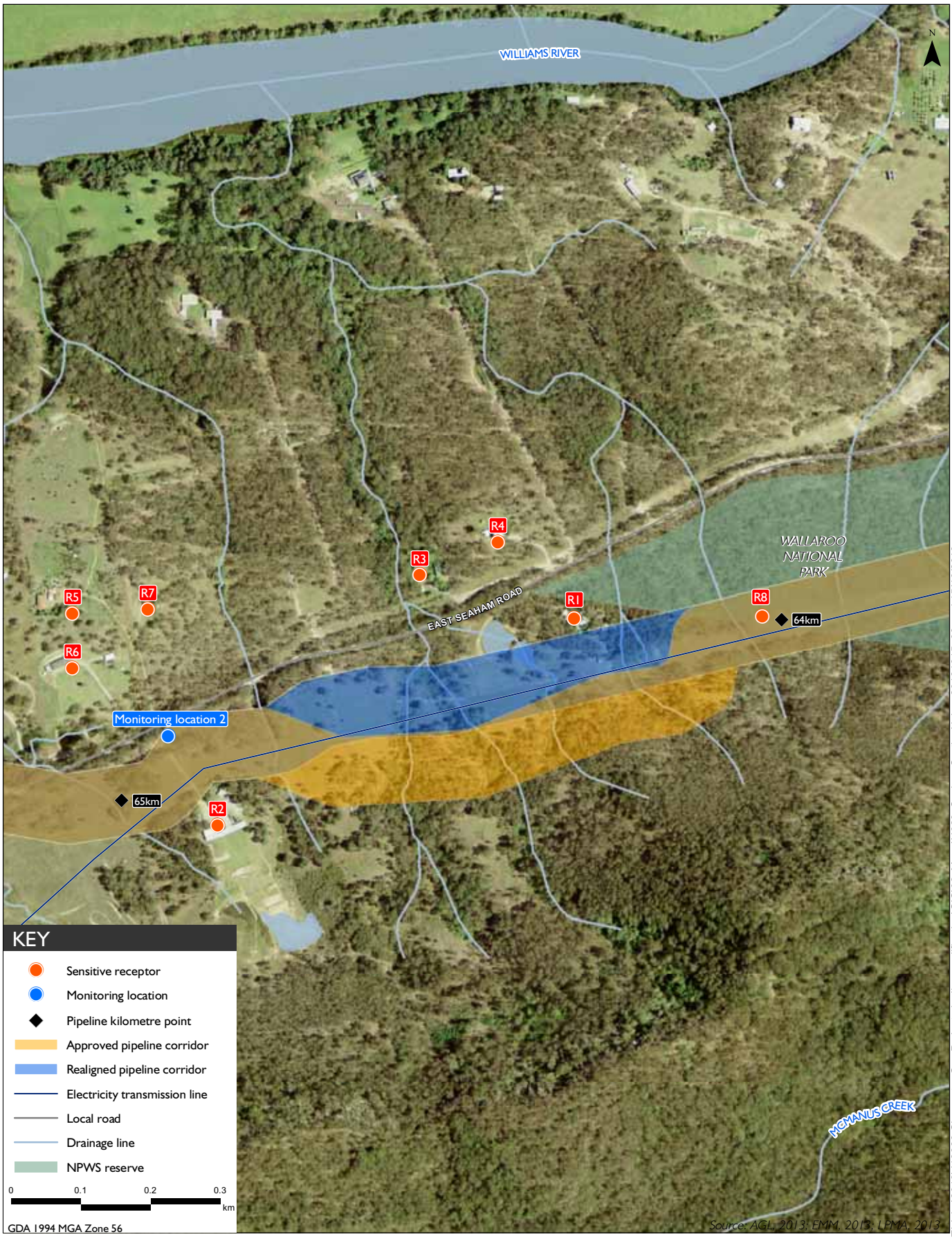
To allow flexibility in final siting and design of the pipeline, and consistent with the approach in the AECOM (2009) EA for the approved project, this assessment has generally considered a 100 m wide pipeline corridor. However, the disturbance footprint for construction will be within a right of way (ROW) up to around 30 m wide. HDD activities at the Hunter River and Pacific Highway will also require a temporary laydown and pipe stringing area on cleared land within and adjacent to the 100 m wide pipeline corridor at the Tomago section. No vegetation clearing is required within the laydown and pipe stringing area and ground disturbance will be minimal, likely to limited to gravel access tracks. The anticipated maximum footprint for these activities is shown indicatively on Figure 1.5 and has been considered accordingly in this assessment.



Locality plan showing the proposed modification

Minor pipeline corridor realignments EA - Noise and vibration assessment

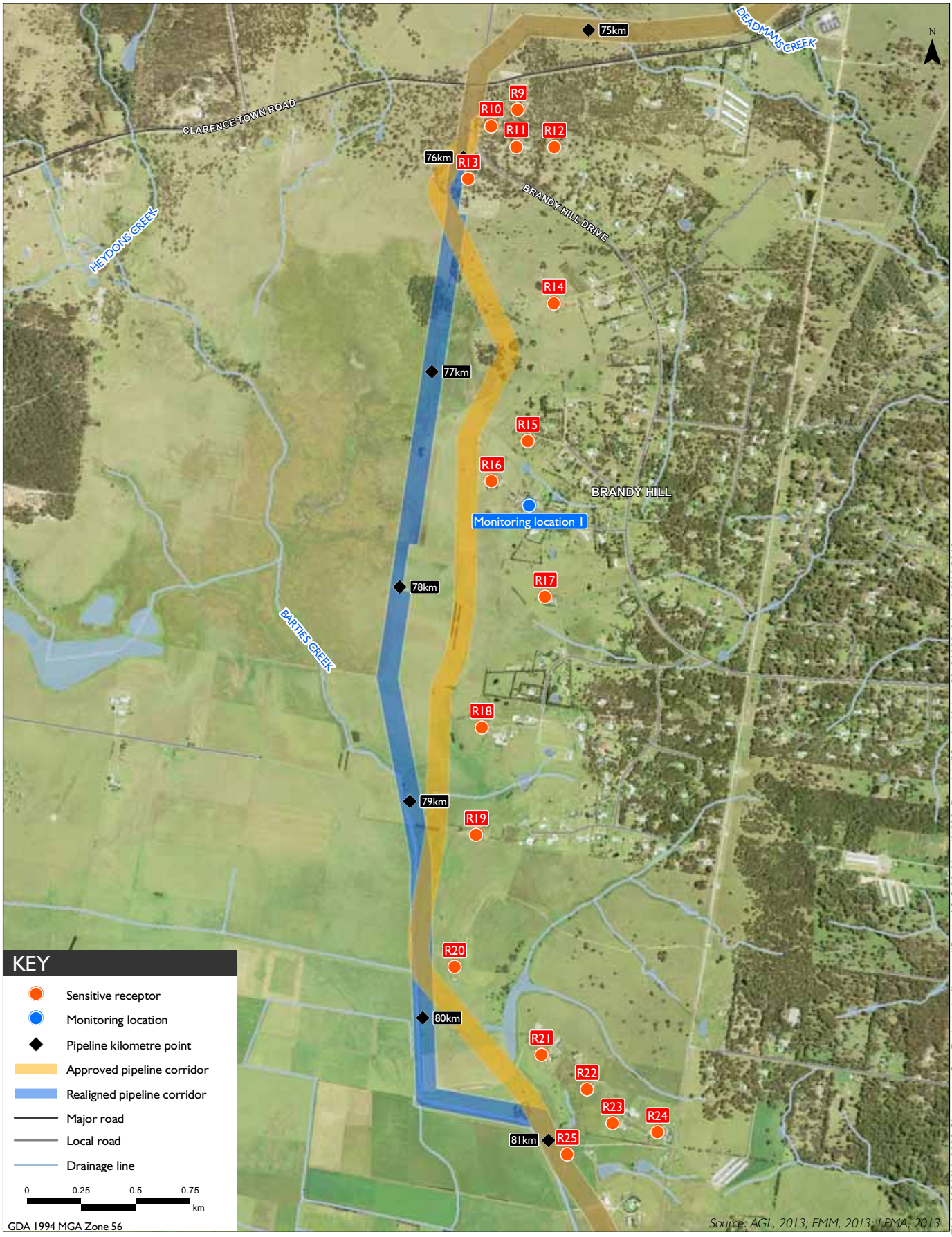
Figure 1.1



Seaham section - short term monitoring locations and sensitive receptors

Minor pipeline corridor realignments EA - Noise and vibration assessment

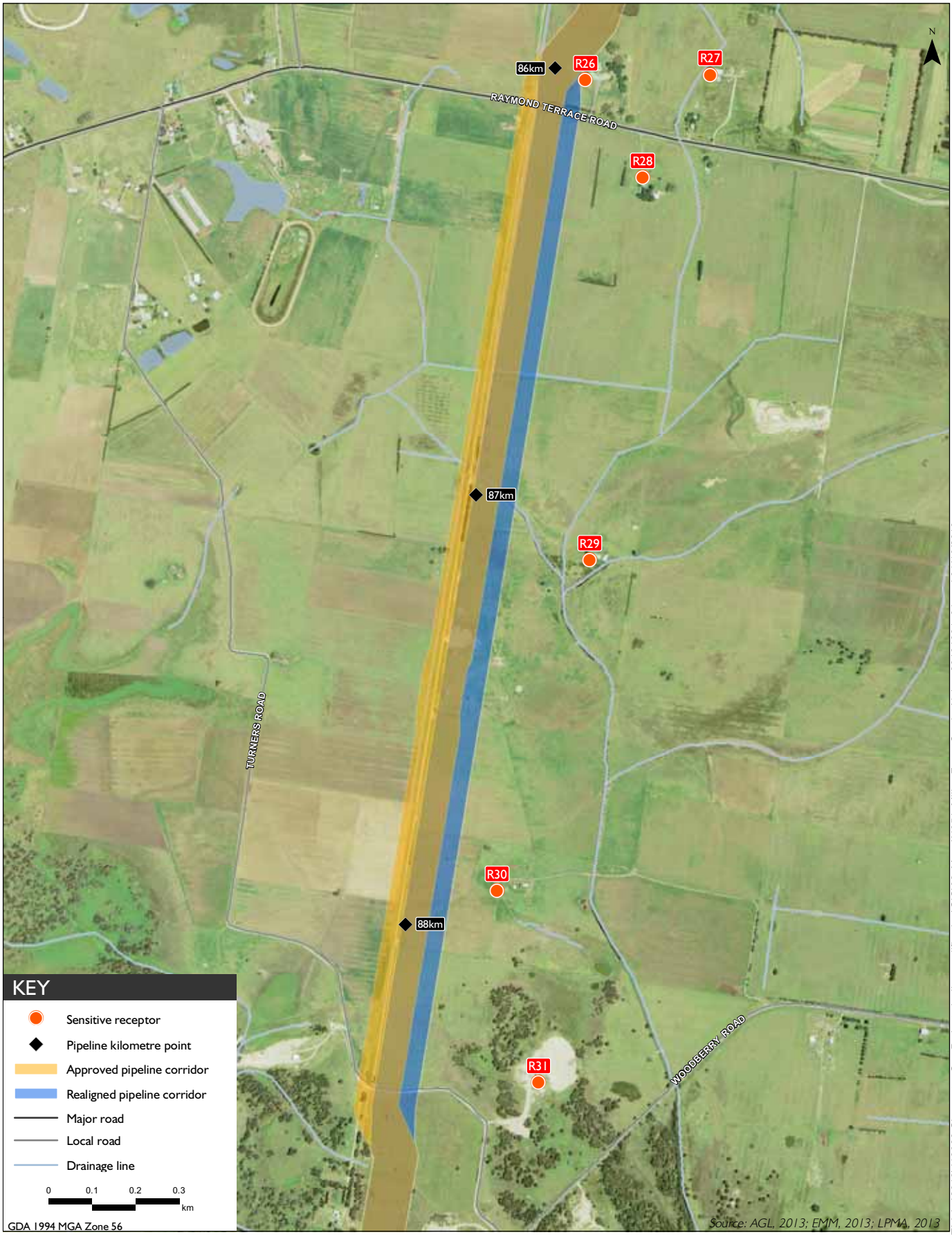
Figure 1.2



Brandy Hill section - short term monitoring locations and sensitive receptors

Minor pipeline corridor realignments EA - Noise and vibration assessment

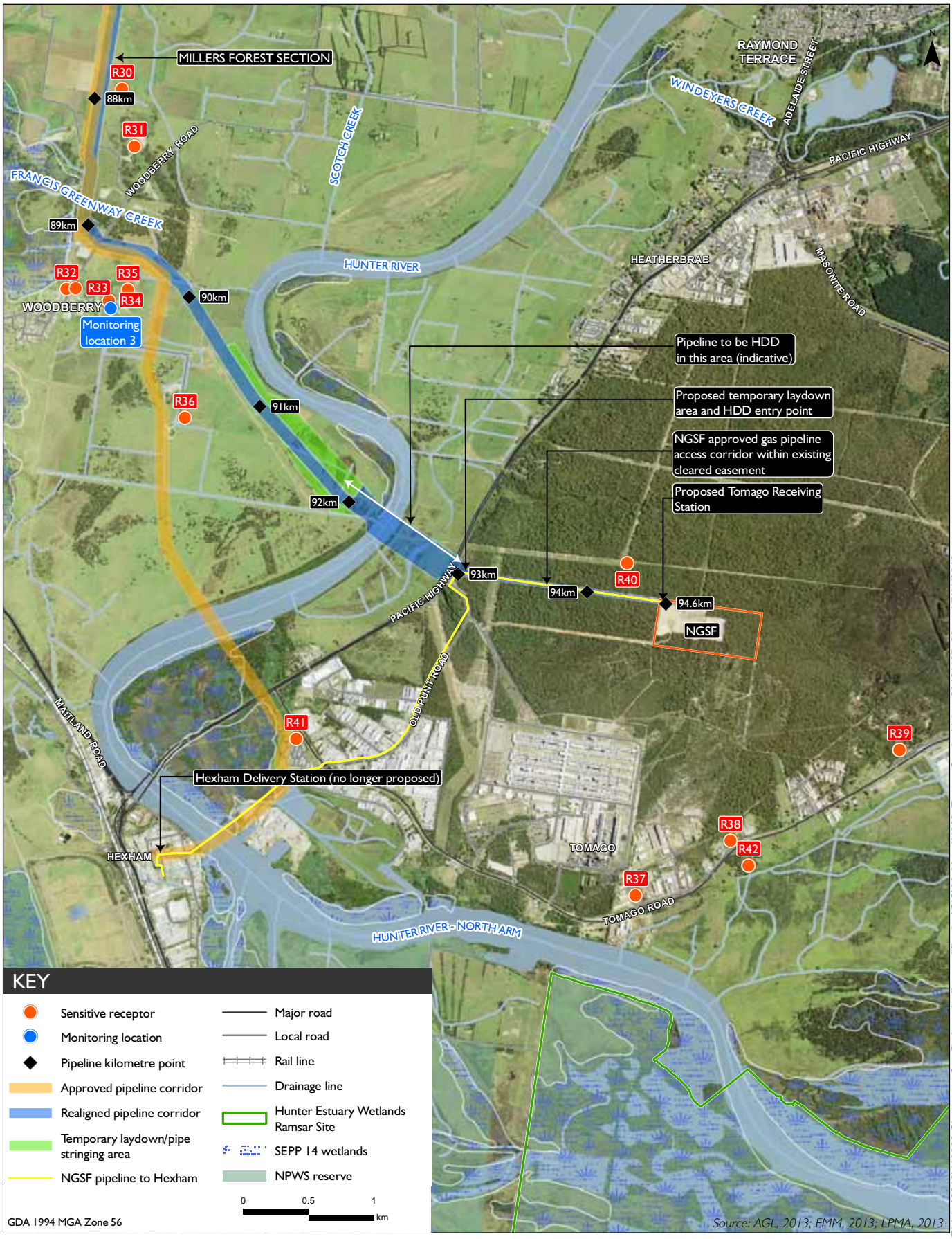
Figure 1.3



Millers Forest section - sensitive receptors

Minor pipeline corridor realignments EA - Noise and vibration assessment

Figure 1.4



Tomago section - short term monitoring locations and sensitive receptors

Minor pipeline corridor realignments EA - Noise and vibration assessment

Figure 1.5

Disturbed areas will be rehabilitated consistent with the existing landuse after construction, with ongoing maintenance activities limited to an approximately 10 m wide easement above the buried pipeline. Further details on the proposed modification are provided in the EA main report.

1.3 Overview of potential impacts and assessment methodology

The 2009 noise and vibration assessment for the approved pipeline and HDS assessed the potential for noise impacts from their construction and operation, including road noise impacts from project-related traffic, as well as the potential for vibration and/or blasting impacts during construction.

Standard operation of the gas transmission pipeline would generally not generate noise, though periodic events such as emergency venting at the MLV could generate temporary short-term noise. The assessment for the pipeline therefore focused on the potential construction impacts. It predicted noise levels from various anticipated pipeline construction activities at various off-set distances, ranging from 25 m to 3 km, to represent potential receptor locations along the pipeline route.

The 2009 study also quantified the potential noise impacts associated with construction and operation of the HDS. It predicted noise levels from various anticipated construction activities at various off-set distances, ranging from 100 m to 1 km, to represent potential receptor locations. Operational noise was anticipated to be generated from continuous operation of valves and fittings and pipe radiated noise. Predicted operating noise levels under high and low flow conditions were modelled and assessed at sensitive receptors under calm conditions and a range of other meteorological conditions which are assessable under the Environment Protection Authority (EPA) (2000) *NSW Industrial Noise Policy* (INP).

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, noise generation would be unchanged. This assessment has applied a similar methodology to Atkins (2009) to determine whether the minor change to the location of activities in the Seaham, Brandy Hill, Millers Forest and Tomago sections would result in any change to results of the original assessment. It focuses on potential noise and vibration impacts associated with the pipeline's construction and potential noise impacts from construction and operation of the TRS. It has also considered whether the proposed modification would necessitate any additional management or monitoring measures beyond those which AGL is already committed to for the GGP, as documented in the Project approval (PA 08_0154) conditions.

The guidelines and standards referenced in this report are generally consistent with those used in the 2009 study, with the exception of the road traffic noise assessment guidelines. The EPA (1999) *Environmental Criteria for Road Traffic Noise* used in the 2009 study has been superseded by the Department of Environment, Climate Change and Water (DECCW) (2011) *NSW Road Noise Policy* (RNP). Accordingly, the RNP has been referenced in preparing this report.

1.4 Existing approvals

The GGP is subject to a series of approvals and licence conditions which will also be applied to the modified sections of pipeline and the TRS where relevant. The Project approval (PA 08_0154) includes existing conditions relating to the management of noise and vibration, which will provide the basis for managing any identified impacts associated with the proposed realigned sections of pipeline and the TRS. These measures are discussed in Section 3.1 and Chapter 6.

2 Existing environment

2.1 Potentially affected receptors

The 2009 study identified that residences are typically more than 200 m from the proposed pipeline corridor, though there are a small number of residences in the order of 30 m to 100 m (estimated from aerial photography) from the corridor's centre-line. The ROW may not necessarily coincide with the corridor's centre-line, however, noise predictions have been made for a range of setback distances from which potential noise levels at other locations can be interpreted.

Aerial photographs were analysed to identify the closest sensitive receptors to the realigned sections and TRS. These are shown on Figures 1.2 to 1.5 and representative receptors selected for assessment are identified in Table 2.1, along with approximate offset distances to the realigned corridor centreline or TRS as applicable. All houses identified were conservatively assumed to be a potentially affected receptor and assessed, irrespective of whether or not they are occupied.

For assessment of the TRS, adjacent to the NGSF, similar receptors were used as in the EMM (2013) noise and vibration assessment for a proposed modification to the NGSF. These are the receptors identified as R37 to R42 in Figure 1.5 and Table 2.1.

Table 2.1 Sensitive receptor locations

ID	Address / description	Receptor type	Approximate distance to proposed pipeline corridor/TRS (m)
Seaham section			
R1[1]	730 East Seaham Road (AGL-owned)	Residential	45
R2[2]	668 East Seaham Road (gun club)	Active recreation	115
R3[3]	717 East Seaham Road	Residential	185
R4[3]	735 East Seaham Road	Residential	205
R5	667 East Seaham Road	Residential	335
R6	Lot 2 667 East Seaham Road	Residential	295
R7	671 East Seaham Road	Residential	250
R8	Wallaroo National Park	Passive recreation	N/A[4]
Brandy Hill section			
R9	994 Clarence Town Road	Residential	285
R10	104 Brandy Hill Drive	Residential	140
R11	102 Brandy Hill Drive	Residential	235
R12	100 Brandy Hill Drive	Residential	405
R13	115 Brandy Hill Drive	Residential	50
R14	83 Brandy Hill Drive	Residential	515
R15	19 Neika Close	Residential	500
R16	22 Werai Close	Residential	355
R17	12 Warrigal Close	Residential	690
R18	153 Warrigal Close	Residential	400
R19	2C McClymonts Swamp Road	Residential	280
R20	Lot 152 Unnamed Road	Residential	150

Table 2.1 Sensitive receptor locations

ID	Address / description	Receptor type	Approximate distance to proposed pipeline corridor/TRS (m)
R21	Lot 2 Ralstones Road	Residential	545
R22	6 Ralstones Road (under construction)	Residential	260
R23	42 Ralstones Road	Residential	345
R24	38 Ralstones Road	Residential	540
R25	Unnamed property - Ralstones Road	Residential	190
Millers Forest section			
R26	947 Raymond Terrace Road	Residential	45
R27	969 Raymond Terrace Road	Residential	310
R28	Lot 111A Raymond Terrace Road	Residential	215
R29	576 Unnamed Road	Residential	230
R30	244 Woodberry Road	Residential	145
R31	265 Woodberry Road	Residential	310
Tomago section			
R32	410 Woodberry Road	Residential	425
R33	407 Woodberry Road	Residential	375
R34	33 Nilands Lane	Residential	400
R35	39-41 Nilands Lane	Residential	300
R36	135 Oakfield Road - Oakfield Ranch	Active recreation	510
R37	9 School Drive	Residential	2,000[5]
R38	45 School Drive	Residential	1,700[5]
R394[3]	5 Graham Drive	Residential	2,125[5]
R40	Hunter Region Botanic Gardens	Passive recreation	245[5]
R41	Tomago Village Caravan Park	Residential[6]	2,600[5]
R42	Historic Tomago House	Passive recreation	1,930[5]

Notes: *1. AGL-owned.*

2. Gun club.

3. Shielded by intervening topography.

4. Wallaroo National Park adjoins the Seaham section. An indicative distance of 1 m was used for calculations in this report.

5. Distance to proposed TRS.

6. Land use conservatively assumed to be residential.

It is noted that the closest identified receptor is the Wallaroo National Park which directly adjoins the Seaham section. However, there are no park facilities at this location, which is unlikely to be regularly visited (the noise criteria for the park only apply when it is in use). Further, the approved pipeline corridor alignment passes through the Wallaroo National Park.

Otherwise, the nearest sensitive receptors to the realigned sections of pipeline corridor are within the range of offset distances identified and assessed in the 2009 study. The proposed realignments within the Seaham, Brandy Hill and Millers Forest sections and the western end of the Tomago section are relatively minor. Sensitive receptors are therefore the same for the approved and proposed modified pipeline corridor alignment. Potentially sensitive receptors for the eastern end of the pipeline corridor and TRS, at Tomago, are different to those identified and assessed for the pipeline corridor and HDS at Hexham. The proposed activities at Tomago will generally be further from sensitive receptors than was the case for the

previously assessed and approved activities at Hexham. This includes the Tomago Village Caravan Park which now lies outside the range of potential impact from pipeline construction.

Overall the proposed modification would result in the pipeline being slightly closer to some receptors at these locations and further from others, as follows:

- Seaham section: up to 100 m closer to some receptors along East Seaham Road;
- Brandy Hill section: up to around 60 m closer to a receptor at its northern end, and up to 335 m further from receptors to the east, in Brandy Hill;
- Millers Forest section: around 50 m closer to receptors east of the alignment and around 50 m further from receptors to the west; and
- Tomago section: more than 40 m further from receptors in and around Woodberry, around 370 m further from Oakfield Ranch, approximately 1.7 km further from Tomago Village Caravan Park and closer to the Hunter Region Botanic Gardens.

The 2009 study predicted noise and vibration levels at various offset distances that represented potential receptor locations in the vicinity of proposed construction activities. This assessment has quantified the anticipated received noise levels at these same offset distances, as well as at the closest potentially affected receptors identified in Table 2.1 and Figures 1.2 to 1.5. This assessment is presented in Chapter 4.

2.2 Ambient noise environment

2.2.1 Modified pipeline corridor alignment

The 2009 noise assessment conducted as part of the original AECOM (2009) EA characterised the ambient noise environment. It identified several influences on the acoustic environment along the approved pipeline corridor alignment, ranging from mining and industrial activities to rural and conservation areas dominated by rural and natural sounds with limited traffic influences.

The 2009 study included attended and unattended noise monitoring to assess and confirm Rating Background Levels (RBLs) and ambient noise levels. The monitoring focussed on characterising background noise in the vicinity of the Stage 1 Gas Field Development Area (GDFA), central processing facility sites and the HDS. In the absence of monitoring data, the RBL along the pipeline corridor was conservatively assumed to be 30 dB(A), consistent with the INP's minimum recommendation.

To determine background noise levels in the vicinity of the proposed pipeline corridor realignments, attended noise measurements were completed by EMM on 4 October 2013. Three monitoring locations were selected to characterise the background noise environment in the vicinity of the Seaham, Brandy Hill, Millers Forest and Tomago sections. The monitoring locations are shown in Figures 1.2, 1.3 and 1.5.

Background noise levels were measured and assessed in accordance with the INP's 'Short-term Method' for determining background noise. The attended noise measurements were completed using a Brüel and Kjær 2250 one-third octave band integrating sound level meter. Field calibration of the instrument was undertaken using a Brüel and Kjær type 4230 calibrator.

Measurements were undertaken in accordance with the relevant Australian Standard *AS1055-1997 Description and Measurement of Environmental Noise* Parts 1, 2 and 3. Meteorological conditions

throughout the survey period were influenced by increasing winds, though average wind speeds did not exceed 5 m/s. No rain events were experienced.

The 'Short-term method' for determining background noise is outlined in Section 3 of the INP and is used for activities considered to be low-risk, such as short-term construction activities proposed as part of the modification**.** Table 2.2 outlines the procedure for determining background noise levels using the short-term method, as well as the assessment scenarios under which it can be applied. For comparative purposes the same information is presented for the 'Long-term method'.

Table 2.2 INP methods for determining background noise

	Long-term	**Short-term**
When to use	During planning and approval stage where there is significant potential for noise impact, eg extractive industries and industrial developments.	During complaint assessments, compliance checks, when determining the effect of background noise on a source noise measurement and for low risk developments.
Type of monitoring	Continuous sampling accompanied by periods of operator-attended monitoring.	Individual sampling—operator-attended measurements.
Length of monitoring	Equivalent to one week's worth of valid data covering the days and times of operation of the development (see Section 3.5 of INP).	15-minute measurements covering the times of operation of the development.
Conditions for monitoring	Average wind speed <5 m/s no rain, no extraneous noise (see Sections 3.1.2 and 3.4 of INP).	Average wind speed <5 m/s, no rain, no extraneous noise (see Sections 3.1.2 and 3.4 of INP).
Monitoring location	Most or potentially most affected noise-sensitive location/s.	Most affected noise-sensitive location and/or location of complaint.
Assessment time periods	Day (0700–1800) Evening (1800–2200) Night (2200–0700) (see Section 3.3 of INP for exceptions).	Times when maximum impacts occur.

The results of the short-term measurements are presented in Table 2.3.

Table 2.3 Short-term 15-minute attended background noise measurements – 4 October 2013

Location	**Duration**	**Date**	**Start time**	**Total measured noise levels, dB(A)**		**Comments**
				L_{90}	L_{eq}	
M2 - 668 East Seaham Rd[1] (Seaham)	15 minutes	4/10/2013	08:36	39	56	Minimal traffic. Car passbys and rural and animal noises audible. Increasing winds.
M1 – Werai Cl (Brandy Hill)	15 minutes	4/10/2013	07:43	38	48	Nature, dogs, birds and distant traffic noise audible.
M3 - 33 Nilands Ave (Tomago and Millers Forest)	15 minutes	4/10/2013	09:19	41	57	Background traffic, car passbys and suburban hum audible. Plane flyovers and train passbys. Increasing winds.

Notes: 1. Data collected after 10 minutes was affected by winds and so was excluded.

The noise environment at East Seaham Road (representative of receptors at the Seaham section) was found to be rural, with some traffic influence and animal noises. The measurement excluded data after 10 minutes that were affected by winds.

The background noise environment at Werai Close (representative of receptors at the Brandy Hill section) was found to be that of a rural environment. It was dominated by rural and natural sounds with minimal traffic noise.

The noise environment at Nilands Lane (representative of receptors at the western end of the Tomago section and the Millers Forest section) was found to be suburban, with constant traffic influences, regular (distant) train passbys and plane flyovers. Distant traffic was audible from the New England Highway, and the environment was otherwise influenced by animal and bird noises. Towards the end of the measurement, elevated wind speeds began to influence the noise levels. Other traffic influences included road traffic noise from the Pacific Highway to the east, which is a major transport corridor linking Sydney and Brisbane. Some parts of the Millers Forest and potentially the Tomago section have background noise environments which are more typically rural. Areas around the Tomago section's eastern end are influenced by urban and industrial noise sources, including traffic.

2.2.2 TRS

The TRS is proposed to be located at an industrial area adjacent to the NGSF (refer Figure 1.5). The 2009 study included attended and unattended noise monitoring to characterise background noise in the vicinity of the HDS, at Hexham. The proposed TRS, at Tomago, is around 4.3 km north-east of the formerly-proposed HDS and has a different ambient noise environment. Therefore, background noise data collected for assessment of the HDS is not relevant for the TRS.

The background noise environment in the vicinity of the proposed TRS location was however investigated by Atkins (2011) as part of the noise assessment supporting the NGSF Project EA. Ambient monitoring was completed in August and September 2010 at several of the nearest potentially affected sensitive receptors to the NGSF (and TRS). This included monitoring at 5 Graham Drive and at 45 School Drive, which was also taken to be representative of ambient levels in the vicinity of the nearby receptor at 9 School Drive. The ambient noise environment at both of these locations is influenced by existing industry and traffic. Monitoring was also undertaken at Tomago Village Caravan Park and the Hunter Region Botanic Gardens. The Historic Tomago House was not assessed as part of previous studies. The background noise environment for Historic Tomago House is however considered to be similar to that of the nearby School Road receptors. This monitoring data was used to determine RBLs and the results are provided in Table 2.4.

Table 2.4 Background noise levels at nearest sensitive receptors to TRS

Location	Receptor type	RBL[1]		
		Day (7 am to 6 pm)	Evening (6 pm to 10 pm)	Night (10 pm to 7 am)
9 School Drive[2]	Residential	46	44	44
45 School Drive	Residential	46	44	44
5 Graham Drive	Residential	42	39	37
Tomago Village Caravan Park	Residential	50	48	46
Hunter Region Botanic Gardens	Passive recreation	41	39	38
Historic Tomago House[1,2]	Passive recreation	46	44	44

Notes: *1. Source: Atkins 2011.*

2. Background levels adopted from 45 School Drive.

3 Noise and vibration criteria

3.1 Existing approvals

PA 08_0154 for the approved GGP outlines the following limits to be placed on noise and vibration generating activities:

- air blast overpressure limit: 115 dB(linear peak) for 5% of total number of blasts over a 12 month period, with no exceedances of 120 dB(linear peak) (Condition 3.18);
- ground vibration limit: 5 mm/s for 5% of total number of blasts over a 12 month period, with no exceedances of 10 mm/s (Condition 3.19); and
- vibration impacts: vibration resulting from construction and operation of the project not to exceed the preferred values vibration presented in the Department of Environment and Conservation NSW (DEC) (2006) *Assessing Vibration: A Technical Guideline* (Condition 3.21).

Condition 3.22 outlines detailed noise limits for the operation of various aspects of the GGP, but does not provide limits relevant to the proposed gas transmission pipeline. Limits are provided for the HDS, however these will not be relevant for the proposed TRS given that the ambient noise environment at Hexham is different to Tomago. As a result, criteria specifically for the TRS have been determined as part of this report, which are to be applied in place of those prescribed in the Project approval conditions for the HDS.

This assessment has been completed in consideration of the above limits and requirements, and an assessment has been provided as to the applicability of existing approved measures in addressing the proposed pipeline modifications and TRS.

3.2 Construction noise

Consistent with the approved pipeline, noise during construction of the realigned sections will be generated during site preparation activities and the pipeline's installation, as well as construction of ancillary facilities such as access tracks and the MLV facility. Noise will also be generated during TRS construction, including from earthworks and civil and construction works. Noise has been assessed at potential sensitive receptors using criteria developed in accordance with the Department of Environment and Climate Change (DECC) (2009) *Interim Construction Noise Guidelines* (ICNG) and DECCW (2011) RNP, which are outlined in the following sections.

3.2.1 Construction hours and noise objectives

Construction noise objectives aim to minimise noise impacts on surrounding receptors. The ICNG sets out noise objectives for standard and out of hours (OOH) construction work where noise from these activities is audible at residential premises. Standard hours for construction are defined in the ICNG as:

- Monday to Friday 7 am to 6 pm;
- Saturday 8 am to 1 pm; and
- no construction work on Sundays or public holidays.

The existing approval conditions for the GGP, which will also be applied to the proposed modification, permit pipeline construction outside standard hours in accordance with Condition 3.14, as follows:

> Construction works associated with the gas pipeline that would generate audible noise at any sensitive receptor shall only be undertaken during the following hours: 7 am to 6 pm Monday to Saturday and 8 am to 6 pm Sundays or public holidays for a maximum period of 28 days at a time, separated by a minimum respite period of nine days.

Some activities such as HDD may also need to be undertaken 24 hours per day. Condition 3.16 provides that construction hours may be varied from those specified above, with the written approval of the Director-General, and subject to provision of the information specified in Condition 3.16.

The ICNG provides two methodologies to assess construction noise emissions:

- quantitative, which is suited to major construction projects with typical durations of more than three weeks; and
- qualitative, which is suited to short-term projects of less than three weeks.

A quantitative assessment requires noise emission predictions from construction activities at the nearest receptors, while the qualitative assessment is a simplified approach that relies more on noise management strategies. The qualitative aspects of the assessment include identification of receptors, description of works involved and proposed management measures, including a complaints handling procedure.

While the construction project for the entire approved pipeline is scheduled to occur for 12 months, construction time (and associated noise exposure) in most locations along the pipeline corridor is expected to be less than three weeks, due to the transient nature of the activities. Construction timeframes would be longer in some instances such as for the HDD, TRS and MLV facility.

The 2009 study qualitatively assessed impacts of pipeline construction and quantitatively assessed potential impacts from HDS construction. This approach has been expanded in this assessment of the proposed modification to quantify potential noise impacts at sensitive receptors near the Seaham, Brandy Hill, Millers Forest and Tomago sections. It provides construction noise criteria for standard and OOH periods. Consistent with the approach for a qualitative assessment it also identifies sensitive receptors and describes the proposed works and management and mitigation, including complaints handling procedures. Accordingly, this study has adopted a combination of a quantitative and qualitative assessment approach.

3.2.2 Noise management level

Table 3.1 provides noise management levels for residential receptors, reproduced from the ICNG.

Table 3.1 Construction noise management level for residences

Time of day	Management level $L_{eq(15\text{-}min)}$	Application
Recommended standard hours: Monday to Friday 7 am to 6 pm, Saturday 8 am to 1 pm and no work on Sundays or public holidays	Noise-affected RBL + 10 dB	The noise-affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{eq(15\text{-}min)}$ is greater than the noise-affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise-affected level represents the point above which there may be strong community reaction to noise. • Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: i) times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences); and ii) if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise-affected RBL + 5 dB	A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise-affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise-affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see Section 7.2.2 of the ICNG.

Source: ICNG (DECC 2009)

Table 3.2 is an extract from the ICNG and provides noise management levels for sensitive land uses (other than residences). These criteria apply to all periods when the properties are in use.

Table 3.2 Noise management level for sensitive land uses (other than residences)

Land use	Management level, $L_{eq(15\text{-}min)}$ (applies when properties are being used)
Classrooms at schools and other educational institutions.	Internal noise level - 45dB(A).
Hospital wards and operating theatres.	Internal noise level - 45dB(A).
Places of worship.	Internal noise level - 45dB(A).
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion).	External noise level - 65dB(A).
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation).	External noise level - 60dB(A).

Table 3.2 Noise management level for sensitive land uses (other than residences)

Land use	Management level, $L_{eq(15\text{-}min)}$ (applies when properties are being used)
Community centres.	Depends on the intended use of the centre. Refer to the recommended 'maximum' internal levels in AS2107 for specific uses.

Source: ICNG (DECC 2009)

The above management levels have been used to determine the construction criteria for the proposed modification. Based on results of the background noise monitoring and assessment (Tables 2.3 and 2.4), the construction noise criteria for sensitive receptors in the vicinity of the proposed realigned sections of pipeline corridor and TRS are presented in Table 3.3 and Table 3.4 respectively. The criteria are provided for standard and OOH construction activities. Receptor R1 in the Seaham section is AGL-owned, however has been included in this assessment for completeness.

Table 3.3 Construction noise criteria – standard and out of hours pipeline construction

Receptors	Period	RBL, dB(A)	Criteria, Leq(15-min)	
			Standard hours[1]	OOH[1]
Residential receptors - Seaham (R1, R3-R7)[2]	Day	39	49	44
Residential receptors – Brandy Hill (R9-R25)	Day	38	48	43
Residential receptors – Millers Forest section (R26-R31)	Day	41	51	46
Residential receptors - Tomago (R32-R35)	Day	41	51	46
Active recreation receptors (R2, R36)	When in use	N/A	65	65
Passive recreation receptors (R8, R40)	When in use	N/A	60	60

Notes: 1. Standard hours are Monday to Friday 7 am to 6 pm; Saturday 8 am to 1 pm; and no construction work on Sundays or public holidays (DECC 2009). The criteria for OOH work apply to all works outside of standard hours.

2. Receptor R1 is AGL-owned.

Table 3.4 Construction noise criteria – standard and out of hours TRS construction

Receptors	Period	RBL, dB(A)	Criteria, Leq(15-min)	
			Standard hours[1]	OOH[1]
Residential receptors – Tomago (R37-R38)	Day	46	56	51
Residential receptors – Tomago (R39)	Day	42	52	47
Residential receptors– Tomago (R41)	Day	50	60	55
Passive recreation receptors (R40)	When in use	N/A	60	60

Notes: 1. Standard hours are Monday to Friday 7 am to 6 pm; Saturday 8 am to 1 pm; and no construction work on Sundays or public holidays (DECC 2009). The criteria for OOH work apply to all works outside of standard hours.

3.3 Operational Noise

3.3.1 TRS and pipeline

As described previously, standard operation of the pipeline is not expected to generate noise.

The operational noise assessment for the TRS was completed with reference to Condition 3.22 of the GGP Project approval. However as previously stated, the limits placed on operational noise from the HDS are not applicable to the TRS. To assess potential impacts from operation of the TRS, separate criteria have been determined. They are based on background noise levels derived for the area by Atkins (2011) as part of the noise and vibration assessment of the NGSF Project (refer Section 2.2.2). As the receptors to be assessed are the same as for the NGSF, these background noise levels will be consistent for this assessment. The determination of operational noise criteria used the same methods as in the 2009 study for the HDS.

Intrusive $L_{Aeq(15minute)}$ and amenity $L_{Aeq(period)}$ criteria were determined for each assessment period (day, evening and night) in accordance with the EPA (2000) INP. Intrusive criteria are based on the rating background level (RBL) + 5 dB(A). The amenity criteria adopted were the INP recommended 'acceptable' noise levels for given land uses, for example suburban residential. The INP requires that both the intrusiveness and amenity criteria are satisfied. However, the more limiting of the two becomes the project specific noise level (PSNL) or operational criteria.

The intrusive criteria, which are applicable to residential receptors, are presented in Table 3.5. The amenity criteria for passive recreation areas are also provided in Table 3.5.

Table 3.5 Sensitive receptor operational criteria

Receptor type	Period	Rating background level (RBL), dB(A)[1]	Intrusive criteria dB(A), $L_{eq,15\text{-}min}$ (PSNL)
Residential receptors (R37-R38)	Day (7 am to 6 pm)	46	51
	Evening (6 pm to 10 pm)	44	49
	Night (10 pm to 7 am)	44	49
Residential receptor (R39)	Day (7 am to 6 pm)	42	47
	Evening (6 pm to 10 pm)	39	44
	Night (10 pm to 7 am)	37	42
Residential receptor (R41)	Day (7 am to 6 pm)	50	55
	Evening (6 pm to 10 pm)	48	53
	Night (10 pm to 7 am)	46	51
		Recommended $L_{eq,15\text{-}min}$ noise level	
		Acceptable	**Maximum**
Passive recreation area	When in use	50	55

Note: 1. Source: Atkins (2011).

3.3.2 Cumulative noise

Cumulative noise emissions from multiple industrial sources may impact on the acoustic amenity of surrounding communities. To limit continuing increases in industrial noise within a particular area, ambient industrial noise should not exceed the levels specified in Table 2.1 of the INP.

A cumulative noise assessment for the TRS has been made in accordance with the INP, considering existing industrial noise sources in the Tomago area and anticipated future operating noise from the approved NGSF, based on predictions in its EA. The criteria used are the INP's acceptable and recommended maximum amenity criteria levels, presented in Table 3.6.

Section 2.2 of the INP states that where existing L_{eq} noise levels are controlled by industrial noise and the level approaches or exceeds the recommended acceptable level, modifications to the acceptable noise level (ANL) should be applied. These modifications are specified in Table 2.2 of the INP. The effect of this is to limit any further increases in noise creep attributable to industrial noise.

Cumulative noise impacts have been assessed at the representative residential and passive recreation receptors near the TRS. Residential receptors at Tomago were identified as being urban in accordance with the INP.

Table 3.6 Recommended acceptable and maximum amenity criteria noise levels

Type of receptor	Indicative noise area	Period	Recommended L_{eq} (period) noise level, dB(A)[1]	
			Acceptable	Maximum
Residential receptors (R37, R38, R39, R41)	Urban	Day	60	65
		Evening	50	55
		Night	45	50
Passive recreation areas (R40, R42)	All	When in use	50	55

3.3.3 Sleep disturbance

The 2009 study did not include a sleep disturbance assessment for operation of the HDS. Rather, it was determined that noise from operational plant would not be greater than 5-10 dB(A) above L_{eq} levels, and therefore it was expected to satisfy the sleep disturbance criteria of background plus 15 dB.

The potential for sleep disturbance from operational activities has been assessed as part of this study.

The EPA provides guidance on assessing sleep disturbance. The EPA nominates that a screening criteria shall apply to maximum noise level events from the site which are to be calculated at one metre from the bedroom facade at the nearest residential properties. The EPA recommends that $L_{1,1minute}$ (or L_{max}) noise from a source should not exceed the existing background noise by more than 15 dB.

Where noise levels have been calculated above the screening criteria, additional analysis should be undertaken, referencing guidance on maximum noise levels and sleep disturbance listed in the RNP (EPA 2011). This guidance states:

- maximum internal noise levels below 50 to 55 dB(A) are unlikely to wake sleeping occupants; and
- one or two noise events per night, with maximum internal noise levels of 65-70 dB(A), are not likely to affect the health and well being of occupants significantly.

Assuming a partially open window, it is commonly accepted by acoustic practitioners and regulatory bodies that external noise levels would be reduced by 10 dB(A). Therefore, external noise levels in the order of 60-65 dB(A) calculated at the facade of a residence are unlikely to cause sleep disturbance affects at worst case (ie with windows open).

Similarly, the World Health Organisation (WHO 1999) suggest that levels below 45 dB(A) inside homes are unlikely to wake sleeping occupants, equating to 55 dB(A) externally (partially open window).

The EPA has acknowledged that the relationship between maximum noise levels and sleep disturbance is not currently well defined. If the background plus 15 dB goal is achieved then impacts are not likely, but where it is not met, a more detailed analysis is required. A detailed analysis would include quantifying the noise level as well as the number of possible events above the ideal background plus 15 dB goal.

The relevant sleep disturbance criteria for the residential receptors in the vicinity of the TRS are presented in Table 3.7.

Table 3.7 Sleep disturbance criteria

Residential receptors	Period	RBL, dB(A)	Sleep disturbance criteria, $L_{1,1min}$
R37-R38	Night	44	59
R39	Night	37	52
R41	Night	46	61

3.4 Road noise

3.4.1 Assessment criteria

The principle guidance to assess the impact of road traffic noise on noise sensitive receptors is in the RNP (DECCW 2011). This policy supersedes that used in the 2009 study, however the criteria are unchanged.

Table 3.8 presents the road noise assessment criteria for residences on major and local roads, reproduced from Table 3 of the RNP.

Table 3.8 Road traffic noise assessment criteria for residential land uses

Road category	Type of project/development	Assessment criteria, dB(A)	
		Day (7 am to 10 pm)	Night (10 pm to 7 am)
Freeway/arterial/sub-arterial roads	Existing residences affected by additional traffic on existing freeway/arterial/sub-arterial roads generated by land use developments.	$L_{eq(15\text{-}hr)}$ 60 (external)	$L_{eq(9\text{-}hr)}$ 55 (external)
Local roads	New road corridor/redevelopment of existing road/land use development with the potential to generate additional traffic on existing road.	$L_{eq(1\text{-}hr)}$ 55 (external)	$L_{eq(1\text{-}hr)}$ 50 (external)

Additionally, the RNP states where existing road traffic noise criteria are already exceeded, any additional increase in total traffic noise level should be limited to 2 dB.

3.4.2 Relative increase criteria

In addition to meeting the assessment criteria, any significant increase in total traffic noise at receptors must be considered. Receptors experiencing increases in total traffic noise levels above those presented in Table 3.9 should be considered for mitigation.

Table 3.9 Relative increase criteria for residential land uses

Road category	Type of project/development	Total traffic noise level increase - dB(A)	
		Day (7 am to 10 pm)	Night (10 pm to 7 am)
Freeway/arterial/sub-arterial roads and transitways	New road corridor/redevelopment of existing road/land use development with the potential to generate additional traffic on existing road.	Existing traffic $L_{eq(15\text{-}hr)}$+12 dB (external)	Existing traffic $L_{eq(9\text{-}hr)}$+ 12 dB (external)

3.5 Construction vibration

Assessment of construction vibration is addressed in the following documents:

- German Standard *DIN 4150 – 1999-02 Structural vibration, Part 3: Effects of vibration on structures*;
- DEC (2006) *Assessing Vibration: a technical guideline*; and
- British Standard *BS 6472 – 2008, Evaluation of human exposure to vibration in buildings (1-80 Hz).*

Criteria prescribed in these documents also form the basis for the limits in Conditions 3.18 and 3.19 of the GGP Project approval.

3.5.1 Human comfort – Assessing vibration a technical guideline

Assessing vibration: a technical guideline was published in February of 2006 by the DEC and is based on guidelines contained in *BS 6472 – 2008, Evaluation of human exposure to vibration in buildings (1-80 Hz).*

The guideline presents preferred and maximum vibration values for use in assessing human responses to vibration. It provides recommendations for measurement and evaluation techniques. At vibration values below the preferred values, there is a low probability of adverse comment or disturbance to building occupants. Adverse comment or complaints may be expected if vibration values approach the maximum values. Where all feasible and reasonable mitigation measures have been applied and vibration values are still beyond the maximum value, it is recommended the operator negotiate directly with the affected community.

The DEC (2006) guideline defines three vibration types and provides direction for assessment and evaluation against the applicable criteria. Table 2.1 of the guideline provides examples of the three vibration types and has been reproduced below in Table 3.10. For the proposed construction activities, the sources are likely to exhibit continuous or intermittent types of vibration, with little or no likelihood of impulsive vibration. Limits for impulsive vibration are less stringent than for continuous vibration and are typically not analysed in the context of vibration assessment. Accordingly impulsive vibration is not discussed further in this report.

Table 3.10 Examples of types of vibration, sourced from Table 2.1 of the DEC (2006) guideline

Continuous Vibration	Impulsive Vibration	Intermittent Vibration
Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).	Infrequent: Activities that create up to three distinct vibration events in an assessment period, eg occasional dropping of heavy equipment, occasional loading and unloading.	Trains, intermittent nearby construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer these would be assessed against impulsive vibration criteria.

i Continuous vibration

Appendix C of the DEC (2006) guideline outlines acceptable criteria for human exposure to continuous vibration (1-80 Hz). The criteria are dependent on both the time of activity (usually daytime or night-time) and the occupied place being assessed. Table 3.11 reproduces the preferred and maximum criteria relating to measured peak velocity.

Table 3.11 Criteria for exposure to continuous vibration

Place	Time[1]	Peak velocity (mm/s)[2,3]	
		Preferred	Maximum
Critical working areas (eg hospital operating theatres, precision laboratories)	Day or night-time	0.14	0.28
Residences	Daytime	0.28	0.56
	Night-time	0.20	0.40
Offices	Day or night-time	0.56	1.1
Workshops	Day or night-time	1.1	2.2

Notes: *1. Daytime is 7 am to 10 pm and night-time is 10 pm to 7 am.*

2. Root mean square (rms) velocity (mm/s) and vibration velocity value (dB re 10 -9 mm/s).

3. Values given for most critical frequency >8Hz assuming sinusoidal motion.

ii Intermittent vibration

Intermittent vibration (as defined in Section 2.1 of the DEC (2006) guideline) is assessed using the vibration dose concept which relates to vibration magnitude and exposure time. Intermittent vibration is representative of activities such as rock hammering or general excavation work. Section 2.4 of the guideline provides acceptable values for intermittent vibration in terms of vibration dose values (VDV). This requires measurement of the overall weighted rms acceleration levels over the frequency range 1 Hz to 80 Hz. To calculate VDV the following formula (refer Section 2.4.1 of the guideline) is used:

$$VDV = \left[\int_0^T a^4(t)dt \right]^{0.25}$$

Where VDV is the vibration dose value in $m/s^{1.75}$, *a (t)* is the frequency-weighted rms of acceleration in m/s^2 and *T* is the total period of the day (in seconds) during which vibration may occur.

The acceptable VDV for intermittent vibration is reproduced in Table 3.12.

Table 3.12 Acceptable VDV for intermittent vibration (m/s $^{1.75}$)

Location	Daytime[1]		Night-time[1]	
	Preferred value, m/s$^{1.75}$	Maximum value, m/s$^{1.75}$	Preferred value, m/s$^{1.75}$	Maximum value, m/s$^{1.75}$
Critical working areas (eg hospital operating theatres, precision laboratories)	0.10	0.20	0.10	0.20
Residences	0.20	0.4	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Notes: *1. Daytime is 7 am to 10 pm and night-time is 10 pm to 7 am.*

2. These criteria are indicative only, and there may be a need to assess intermittent values against continuous or impulsive criteria for critical areas.

There is a low probability of adverse comment or disturbance to building occupants at vibration values below the preferred values. Adverse comment or complaints may be expected if vibration values approach the maximum values. The guideline states that activities should be designed to meet the preferred values where an area is not already exposed to vibration.

3.5.2 Structural vibration criteria – DIN 4150

For structural vibration, measurements should be assessed at the foundation of a building structure. In the absence of a relevant Australian Standard, the German Standard *DIN 4150 - Part 3: 1999-02* provides the strictest guideline levels of vibration velocity for evaluating the effects of vibration in structures. The limits presented in this standard are generally recognised to be conservative.

The DIN 4150 values (maximum levels measured in any direction at the foundation, or maximum levels measured in (x) or (y) horizontal directions, in the plane of the uppermost floor), are summarised in Table 3.13 and shown graphically in Figure 3.1 in the case of foundation levels. For residential and commercial type structures, the standard recommends safe limits as low as 5 mm/s and 20 mm/s respectively. These limits increase with frequency values above 10 Hz. The operational frequency of construction plant typically ranges between 10 Hz to 30 Hz, and hence according to DIN 4150, the safe vibration criteria range for dwellings is 5 to 15 mm/s. For reinforced commercial type buildings the limit is as low as 20 mm/s, while for heritage or sensitive structures the lower limit is 3 mm/s. This assessment has adopted Line 2 of Figure 3.1 as the limiting criteria.

Table 3.13 Structural damage guideline values of vibration velocity – DIN 4150

Type of Structure	Vibration velocity in mm/s			
	At foundation at a frequency of:			Plane of floor of uppermost storey
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz	All frequencies
Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40

Table 3.13 Structural damage guideline values of vibration velocity – DIN 4150

Type of Structure	Vibration velocity in mm/s			
	At foundation at a frequency of:			Plane of floor of uppermost storey
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz	All frequencies
Dwellings and buildings of similar design and/or use	5	5 to 15	5 to 20	15
Structures that because of their particular sensitivity to vibration do not correspond to those listed in Lines 1 or 2[1] and have intrinsic value (eg buildings that are under a preservation order)	3	3 to 8	8 to 10	8

Notes: 1. 'Line' refers to curves in Figure 1 of DIN 4150 (reproduced in Figure 3.1).

2. For frequencies above 100 Hz the higher values in the 50 Hz to 100 Hz column should be used.

These levels are 'safe limits' for which damage due to vibration effects is unlikely to occur. 'Damage' is defined in DIN 4150 to include even minor non-structural effects such as superficial cracking in cement render, enlarging of cracks already present, and separation of partitions or intermediate walls from load bearing walls. Should such damage be observed without vibration levels exceeding the 'safe limits' then it is likely to be attributable to other causes. DIN 4150 also states that when vibration levels higher than the 'safe limits' are present, it does not necessarily follow that damage will occur.

As indicated by the criteria from DIN 4150 in Figure 3.1, high frequency vibration has less potential to cause damage than lower frequencies. Furthermore, the 'point source' nature of vibration from plant causes the vibratory disturbances to arrive at different parts of nearby large structures in an out-of-phase manner, thereby reducing its potential to excite in-phase motion of the low order modes of vibration in such structures.

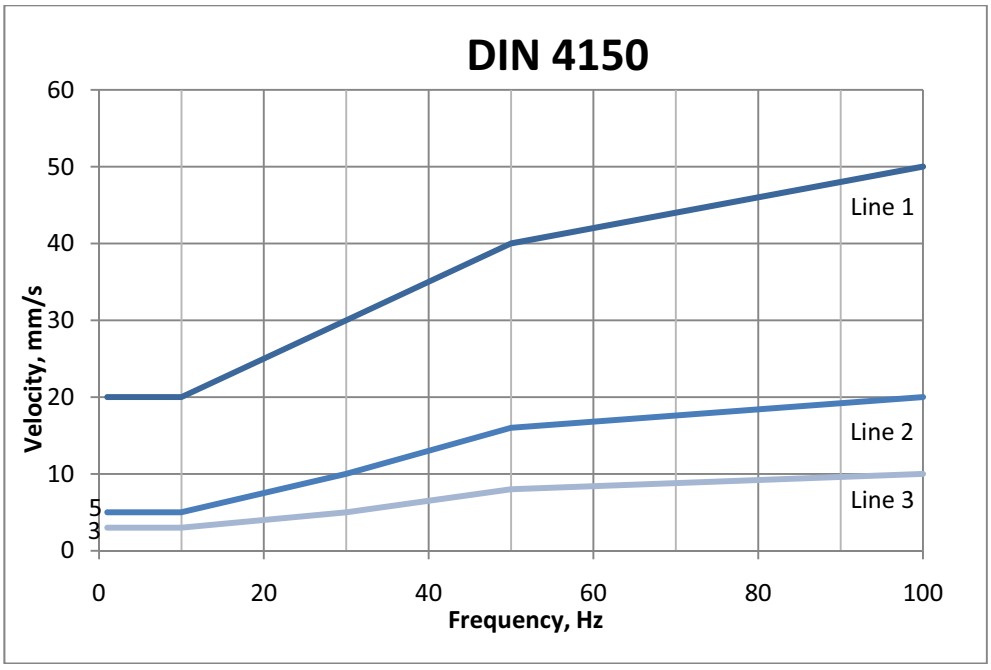


Figure 3.1 DIN 4150 Structural vibration safe limits for buildings

3.6 Blasting

Blasting may be required during construction of the pipeline. The limits adopted by the EPA for blasting are provided in the Australian and New Zealand Environment Conservation Council (ANZECC) (1990) *Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration*.

The blasting limits address two main effects of blasting:

- airblast noise overpressure; and
- ground vibration.

The recommended maximum vibration level for airblast is 115 dB linear peak. The vibration level of 115 dB may be exceeded on up to 5% of the total number of blasts over 12 months. However, the level should not exceed 120 dB linear peak at any time.

Peak particle velocity (PPV) from ground vibration should not exceed 5 mm/s for more than 5% of the total number of blasts over 12 months. However, the maximum level should not exceed 10 mm/s at any time.

A summary of blast limits is provided in Table 3.14. These are the same as the criteria prescribed in Conditions 3.18 and 3.19 of the Project approval.

Table 3.14 Airblast overpressure and ground vibration limits

Airblast overpressure level dB(Lpeak)	**Allowable exceedance**
115	5% of the total number of blasts over 12 months
120	0
Ground vibration Peak particle velocity (mm/s)	**Allowable exceedance**
5	5% of the total number of blasts over 12 months
10	0

4 Construction noise impacts

4.1 Construction noise generating activities

Potential noise generating activities associated with construction of the realigned sections of pipeline are consistent with those identified and assessed in the 2009 study for the approved pipeline. These include:

- site access and clearing;
- site levelling using graders, excavators and bulldozers;
- trenching with a specialist trencher or excavator;
- delivery of pipe adjacent to the trench and pipe stringing, including welding of continuous strings up to 1 km long;
- laying pipe and backfilling; and
- rehabilitation of the construction area.

While these activities are the same as those already assessed and approved, this assessment examines the potential for any change to impacts associated with the relatively minor changes to the proposed corridor alignment. The proposed locations of these activities are within the corridors shown on Figures 1.2 to 1.5. It is noted that the MLV facility will be constructed within the ROW, as part of the pipeline's construction program, and using the same construction hours and equipment as for the rest of the pipeline. Accordingly its potential construction impacts have been addressed as part of the broader impact assessment for construction within the Seaham section.

As identified and assessed for the approved pipeline, vehicle movements associated with the delivery of pipe, plant and equipment for the pipeline construction are expected to involve five to ten trucks and in the order of 15 to 30 light vehicles per day. Vehicle movements associated with construction of the TRS are expected to involve five to ten trucks and 18 light vehicles per day, consistent with predictions for the HDS. Roads to be used by traffic accessing the realigned sections and TRS will be generally consistent with those that would have been used for the approved route and HDS.

Pipeline construction would be undertaken as per the approved schedule, in teams on a rolling basis along the pipeline route. It is anticipated that the total duration of pipeline construction works along the entire approved corridor would be approximately 12 months. The envisaged duration at most locations is however expected to be in the order of three weeks. Construction works would typically be undertaken on a 37 day cycle with crews working 28 days on followed by nine days off, consistent with Condition 3.14 of the existing Project approval.

The TRS and its construction methods will be generally consistent with those assessed and approved for the HDS, with the exception of access road construction which is not required for the TRS; existing access roads to the proposed TRS location will be used.

As mentioned previously, AGL has already committed to a range of noise and vibration management measures to address potential impacts of constructing the GGP pipeline and HDS, many of which will also be applied to the modified sections of pipeline and TRS. These are included in the conditions of Project approval and discussed in Chapter 6. Measures include prescribed times and limits for construction and

blasting; a CEMP that includes measures to monitor and manage noise, vibration and blasting impacts; a community and stakeholder engagement plan; and a complaints procedure.

4.2 Noise sources

Table 4.1 and Table 4.2 present typical equipment and plant to be used for construction of the gas transmission pipeline (including ancillary facilities such as the MLV facility) and TRS respectively, and their sound power levels (SWLs). This information is adapted from the 2009 study.

Table 4.1 Construction noise sources - gas transmission pipeline

Plant	Number	SWL
Access track construction		
Grader	1	103
Water cart	1	103
Vegetation clearing		
Timber shredder	1	118
Grader	1	103
Dozer	2	109
Chainsaw	1	110
Earthworks (site prep/clean up)		
Grader	1	103
Dozer	1	109
Water cart	1	103
Truck	1	105
Pipeline installation		
Trenching machine	1	105
Excavator	1	106
Rock saw	1	102
Side booms	3	104
Padding machine	1	104
Grader	1	103
Water cart	1	103
Truck	1	105
Diesel generator	1	103

Table 4.2 Construction noise sources – TRS

Plant	Number	SWL
Earthworks (site prep/clean up)		
Grader	1	103
Dozer	1	109
Vibrating roller	1	106
Water cart	1	103
Truck	1	105

Table 4.2 Construction noise sources – TRS

Plant	Number	SWL
Civil and construction		
Piling rig	1	116
Water cart	1	103
Bobcat	1	102
Concrete truck/pump	1	106
Crane	1	107
Truck	1	105

Source: Atkins (2009) for the HDS.

4.3 Results

4.3.1 General

Desktop calculations included assessment of impacts from construction equipment operating along the proposed pipeline corridor alignment to representative receptor distances for standard and OOH periods.

It is noted that the duration of works (and associated noise exposure) at most locations is expected to be less than three weeks, and hence while generally a qualitative assessment may be sufficient, this assessment has also quantified potential impacts. The results provided in the following tables should be used as a guide for screening potential noise impacts and a reference in providing suitable noise management and mitigation.

The results in Table 4.3 and Table 4.4 are the predicted (indicative) noise levels over specified distances for anticipated pipeline and TRS construction activities. The results do not consider attenuation from topography or ground absorption and so are considered to be conservative, particularly at the larger distances. It is also assumed that all equipment identified in Tables 4.1 and 4.2 will be operational at one time which provides a worst-case scenario for assessment purposes. Results in Table 4.3 and Table 4.4 are the same as in the 2009 study.

Table 4.3 Predicted pipeline construction noise levels $L_{eq(15\text{-}min)}$, dB(A)

Activity	Distance from construction activity						
	25m	100m	250m	500m	1,000m	2,000m	3,000m
Access track construction	72	60	52	46	40	34	30
Vegetation clearing	83	71	63	57	51	45	41
Earthworks	76	64	56	50	44	38	34
Pipe installation	77	65	57	51	45	39	35

There are no receptors within 100 m of the TRS, therefore no noise predictions have been made at 25 m from construction, as was done for pipeline construction.

Table 4.4 Predicted TRS construction noise levels $L_{eq(15\text{-}min)}$, dB(A)

Activity	Distance from construction activity			
	100m	250m	500m	1,000m
Earthworks	65	57	51	45
Civil and construction	69	61	55	49

Atkins (2009) did not undertake background noise monitoring to establish RBLs (and site-specific construction noise goals) along the pipeline corridor. However in the absence of this data, the INP's minimum recommended background of 30 dB(A) was adopted, and so a target noise goal of 40 dB(A) at residential receptors during standard hours. Based on short-term background monitoring undertaken by EMM for the current assessment, the criteria for residential receptors along the Seaham, Brandy Hill, Millers Forest and Tomago sections was determined to be between 48 dB(A) and 51 dB(A) during standard hours and 43 dB(A) to 46 dB(A) for works outside of standard hours. The results in Table 4.3 and Table 4.4 indicate that construction noise levels are predicted to generally satisfy relevant criteria between approximately 500 m and 1,000 m from the construction activities, consistent with the 2009 study.

Exceedances of the target construction noise goals are expected during construction at receptors located closer than approximately 500 m to the proposed work sites, however these impacts would be temporary and generally short term. Proposed mitigation measures are discussed in Chapter 6 and include a CEMP, community and stakeholders engagement plan and complaints procedure. In summary the results and mitigation measures are the same as for the approved project.

Predictions are provided in the following sections for the closest receptors to the Seaham, Brandy Hill, Millers Forest and Tomago sections.

4.3.2 Seaham section

The modification to the approved pipeline corridor alignment will affect a section of approximately 650 m at Seaham (refer to Figure 1.2). Additionally, the MLV facility is proposed to be constructed within this section. The modified section of pipeline at this location is relatively short and would only temporarily affect a small number of rural residences. These receptors are the same as those that would have been affected by the approved route. Predicted noise levels have been quantified at the potentially affected receptors within approximately 300 m of the modified pipeline corridor alignment.

The predicted noise levels associated with various pipeline construction phases within the Seaham section, including construction of the proposed MLV facility, are presented in Table 4.5, compared against criteria established in accordance with the ICNG.

Table 4.5 Predicted noise levels at receptors – pipeline construction at Seaham section

Receptors	Criteria, dB(A)		Predicted noise levels, $L_{eq(15\text{-}min)}$, dB(A)			
	Standard hours[3]	OOH[3]	Access track construction	Vegetation clearing	Earthworks	Pipeline installation
R1. 730 East Seaham Road[1]	49	44	67	78	71	72
R2. 668 East Seaham Road	65	65	59	70	63	64
R3. 717 East Seaham Road[2]	49	44	51	62	55	56
R4. 735 East Seaham Road[2]	49	44	50	61	62	60

Table 4.5 Predicted noise levels at receptors – pipeline construction at Seaham section

Receptors	Criteria, dB(A)		Predicted noise levels, $L_{eq(15\text{-}min)}$, dB(A)			
	Standard hours[3]	OOH[3]	Access track construction	Vegetation clearing	Earthworks	Pipeline installation
R5. 667 East Seaham Road	49	44	49	60	66	64
R6. Lot 2 667 East Seaham Rd	49	44	51	62	66	64
R7. 671 East Seaham Road	49	44	52	63	66	64
R8. Wallaroo National Park[4]	49	44	100	111	104	105

Notes: *1. AGL-owned.*

2. Shielded by intervening topography, buildings or vegetation.

3. Standard hours are Monday to Friday 7 am to 6 pm; Saturday 8 am to 1 pm; and no construction work on Sundays or public holidays (DECC 2009). The criteria for OOH work apply to all works outside of standard hours.

4. Located immediately adjacent to the pipeline corridor therefore an indicative distance of 1 m was used for calculations.

The predicted noise levels in Table 4.5 are generally consistent with the noise level ranges predicted in 2009 for the approved project.

These results indicate that, as for the approved pipeline, proposed construction activities within the realigned section of pipeline corridor at Seaham would result in exceedances of relevant criteria at most of the closest privately-owned receptors during standard and OOH works. Levels up to 78 dB(A) are predicted at the nearest receptor (730 East Seaham Road) during vegetation clearing activities, which exceeds the 'highly noise affected' criteria defined by the ICNG (refer to Table 3.1). This property is AGL-owned. No privately-owned receptors are predicted to experience exceedances of the 'highly noise affected' criteria.

Noise impacts would however be temporary, during construction of the pipeline and MLV facility, and can be appropriately managed by the existing Project approval conditions for noise impacts, set out in PA 08_0154 (refer Chapter 6).

It is noted that, consistent with the approach in the 2009 study, receptor offset distances (Table 2.1) were calculated from the corridor's centreline. The ROW may not necessarily coincide with the centreline, and could be closer to or further from the edge of the corridor that is closest to sensitive receptors. As an indication, halving the distance between construction activities and the affected receptor would increase the predicted noise levels by approximately 6 dB(A).

Noise management and mitigation measures to be implemented are discussed in Chapter 6.

4.3.3 Brandy Hill section

The modification to the approved pipeline route will affect an approximately 5 km long section at Brandy Hill (refer to Figure 1.3). Construction activities within this section would potentially affect a number of residences in the vicinity of Brandy Hill, which was found to be a relatively quiet rural residential area in the background monitoring survey. These residences are the same as those affected by the approved route and the realigned route will be further most of them, which will effectively reduce potential noise impacts.

Predicted noise levels associated with various pipeline construction phases within the Brandy Hill section are presented in Table 4.6, compared against criteria established in accordance with the ICNG.

Table 4.6 Predicted noise levels at receptors – pipeline construction at Brandy Hill section

Receptors	Criteria, dB(A)		Predicted noise levels, $L_{eq(15\text{-}min)}$, dB(A)			
	Standard hours[1]	OOH[1]	Access track construction	Vegetation clearing	Earthworks	Pipeline installation
R9. 994 Clarence Town Road	48	43	51	62	55	56
R10. 104 Brandy Hill Drive	48	43	57	68	61	62
R11. 102 Brandy Hill Drive	48	43	53	64	57	58
R12. 100 Brandy Hill Drive	48	43	48	59	52	53
R13. 115 Brandy Hill Drive	48	43	66	77	70	71
R14. 83 Brandy Hill Drive	48	43	46	57	50	51
R15. 19 Neika Close	48	43	46	57	50	51
R16. 22 Werai Close	48	43	49	60	53	54
R17. 12 Warrigal Close	48	43	43	54	47	48
R18. 153 Warrigal Close	48	43	48	59	52	53
R19. 2C McClymonts Swamp Road	48	43	51	62	55	56
R20. Lot 152 Unnamed Road	48	43	56	67	60	61
R21. Lot 2 Ralstones Road	48	43	45	56	49	50
R22. 6 Ralstones Road (under construction)	48	43	52	63	56	57
R23. 42 Ralstones Road	48	43	49	60	53	54
R24. 38 Ralstones Road	48	43	45	56	49	50
R25. Unnamed property - Ralstones road	48	43	54	65	58	59

Notes: 1. Standard hours are Monday to Friday 7 am to 6 pm; Saturday 8 am to 1 pm; and no construction work on Sundays or public holidays (DECC 2009). The criteria for OOH work apply to all works outside of standard hours.

The predicted noise levels in Table 4.6 are generally consistent with the noise level ranges predicted in 2009 for the approved project.

These results indicate that, as for the approved pipeline, proposed construction activities within the realigned section of pipeline corridor at Brandy Hill would result in exceedances of relevant criteria at most of the closest receptors during standard and OOH works. Levels up to 77 dB(A) are predicted at the nearest receptor (115 Brandy Hill Drive) during vegetation clearing, which exceeds the 'highly noise affected' criteria defined by the ICNG (refer to Table 3.1). Noise impacts would however be temporary during construction of the pipeline (anticipated to be for less than three weeks at any one location), and can be appropriately managed by the existing Project approval conditions for noise impacts, set out in PA 08_0154 (refer Chapter 6).

It is noted that, consistent with the approach in the 2009 study, receptor offset distances (Table 2.1) were calculated from the corridor's centreline, however the ROW may not necessarily coincide with the centreline. An indication of the potential change in predicted noise levels associated with an increase or decrease in the location of construction activities from a given location is provided in Section 4.3.2.

Noise management and mitigation measures to be implemented are discussed in Chapter 6.

4.3.4 Millers Forest section

The modification to the approved pipeline route will affect an approximately 2.5 km long section at Millers Forest (refer to Figure 1.4). Construction activities within this section would potentially affect nearby residents. These receptors are the same as those that would have been affected by the approved route.

Predicted noise levels associated with various pipeline construction phases within the Millers Forest section are presented in Table 4.7, compared against criteria established in accordance with the ICNG.

Table 4.7 Predicted noise levels at receptors – pipeline construction at Millers Forest section

Receptors	Criteria, dB(A)		Predicted noise levels, $L_{eq(15\text{-}min)}$, dB(A)			
	Standard hours[1]	OOH[1]	Access track construction	Vegetation clearing	Earthworks	Pipeline installation
R26. 947 Raymond Terrace Road	51	46	67	78	71	72
R27. 969 Raymond Terrace Road	51	46	50	61	54	55
R28. Lot 111A Raymond Terrace Road	51	46	53	64	57	58
R29. 576 Unnamed Road	51	46	53	64	57	58
R30. 244 Woodberry Road	51	46	57	68	61	62
R31. 265 Woodberry Road	51	46	50	61	54	55

Notes: 1. Standard hours are Monday to Friday 7 am to 6 pm; Saturday 8 am to 1 pm; and no construction work on Sundays or public holidays (DECC 2009). The criteria for OOH work apply to all works outside of standard hours.

The predicted noise levels in Table 4.7 are generally consistent with the noise level ranges predicted in 2009 for the approved project. These results indicate that, as for the approved pipeline, proposed construction activities within the realigned section of pipeline corridor at Millers Forest would result in exceedances of relevant criteria at most of the closest receptors during standard and OOH works. Levels up to 78 dB(A) are predicted at the nearest receptor (947 Raymond Terrace Road) during vegetation clearing. No other sensitive receptors are predicted to experience levels exceeding the 'highly noise affected' criteria defined by the ICNG. Noise impacts would however be temporary during construction of the pipeline (anticipated to be for less than three weeks at any one location), and can be appropriately managed by the existing Project approval conditions for noise impacts, set out in PA 08_0154 (refer Chapter 6).

It is noted that, consistent with the 2009 study, receptor offset distances (Table 2.1) were calculated from the corridor's centreline, however the ROW may not necessarily coincide with the centreline. An indication of the potential change in predicted noise levels associated with an increase or decrease in the location of construction activities from a given location is provided in Section 4.3.2.

Noise management and mitigation measures to be implemented are discussed in Chapter 6.

4.3.5 Tomago section

The proposed modification to the approved pipeline route will affect an approximately 6.5 km long section at Tomago (refer to Figure 1.5). Construction within the western part of this section would potentially affect residents in the vicinity of Nilands Lane in Woodberry, which was found to be a suburban area with some traffic influence. These residents would have been affected by the approved route and the realigned route will be further from most of them, which will effectively reduce potential

noise impacts. The realigned route will be closer to the boundary of the Hunter Region Botanic Gardens than the approved route. It is noted the assessment location for the botanic gardens is conservatively set at its southern boundary, nearest the pipeline corridor and TRS. There are no facilities at this location and it is unlikely to be regularly visited; the facilities are approximately 600 m further north. The criteria only apply when the area is in use.

Predicted noise levels associated with various pipeline construction phases within the Tomago section are presented in Table 4.8, compared against criteria established in accordance with the ICNG.

Table 4.8 Predicted noise levels at receptors – pipeline construction at Tomago section

Receptors	Criteria, dB(A)		Predicted noise levels, $L_{eq(15\text{-}min)}$, dB(A)			
	Standard hours[1]	OOH[1]	Access track construction	Vegetation clearing	Earthworks	Pipeline installation
R32. 410 Woodberry Road	51	46	47	58	51	52
R33. 407 Woodberry Road	51	46	49	60	53	54
R34. 33 Nilands Lane	51	46	48	59	52	53
R35. 39-41 Nilands Lane	51	46	50	61	54	55
R36. 135 Oakfield Road - Oakfield Ranch	51	46	46	57	50	51
R40. Hunter Region Botanic Gardens	60	60	52	N/A[2]	56	57

Notes: 1. Standard hours are Monday to Friday 7 am to 6 pm; Saturday 8 am to 1 pm; and no construction work on Sundays or public holidays (DECC 2009). The criteria for OOH work apply to all works outside of standard hours.

2. Pipeline construction near the Hunter Region Botanic Gardens will be within an existing cleared easement and will not require vegetation clearing.

The predicted noise levels in Table 4.8 are generally consistent with the noise level ranges predicted in 2009 for the approved project. The results indicate that proposed construction activities within the realigned section of pipeline corridor would result in exceedances of relevant criteria at most of the closest receptors during vegetation clearing, earthworks and pipeline installation during standard and OOH works. Exceedances are predicted at some locations during OOH work for access track construction. Compliance is predicted at the Hunter Region Botanic Gardens.

It is noted that, consistent with the 2009 study, receptor offset distances from the pipeline corridor (Table 2.1) were calculated from its centreline, however the ROW may not necessarily coincide with the centreline. An indication of the potential change in predicted noise levels associated with an increase or decrease in the location of construction activities from a given location is provided in Section 4.3.2.

Predicted noise levels associated with construction of the TRS are presented in Table 4.9, compared against criteria established in accordance with the ICNG.

Table 4.9 Predicted noise levels at receptors – TRS construction

Receptors	Criteria, dB(A)		Predicted noise levels, $L_{eq(15\text{-}min)}$, dB(A)	
	Standard hours[1]	OOH[1]	Earthworks	Civil and construction
R37. 9 School Drive	56	51	39	43
R38. 45 School Drive	56	51	40	44
R39. 5 Graham Drive	52	47	38	42

Table 4.9 Predicted noise levels at receptors – TRS construction

Receptors	Criteria, dB(A)		Predicted noise levels, $L_{eq(15\text{-}min)}$, dB(A)	
	Standard hours[1]	OOH[1]	Earthworks	Civil and construction
R40. Hunter Region Botanic Gardens	60	60	57	61
R41. Tomago Village Caravan Park	60	55	37	41
R42. Historic Tomago House	60	60	39	43

Notes: 1. Standard hours are Monday to Friday 7 am to 6 pm; Saturday 8 am to 1 pm; and no construction work on Sundays or public holidays (DECC 2009). The criteria for OOH work apply to all works outside of standard hours.

The results in Table 4.9 indicate that noise from TRS construction works is predicted to comply with the relevant criteria at all receptors, other than a minor 1 dB(A) exceedance during civil and construction works at the Hunter Region Botanic Gardens. A 1 to 2 dB(A) noise increase would not be noticed by most people. As stated previously, the criteria only apply when in use, and this area of the botanic gardens is unlikely to be regularly visited; the facilities are located approximately 600 m further north.

The proposed TRS is further from sensitive receptors than the previously-proposed HDS, which reduces the potential for construction noise impacts compared to the approved project

Noise impacts would be temporary, during construction, and can be appropriately managed by the existing Project approval conditions for noise impacts, set out in PA 08_0154 (refer Chapter 6).

Construction activities at the Tomago section would also involve the use of HDD techniques to cross the Hunter River and Pacific Highway. These activities would require 24 hour construction as once commenced, HDD needs to continue without interruption for safety and geotechnical reasons. Construction periods of up to two months may also be required. It was identified in the AECOM (2009) EA that a noise impact assessment is to be undertaken for HDD and thrust boring activities prior to construction. This would include identification of sensitive receptors, background noise monitoring (if required), prediction of noise levels and design of mitigation measures to manage noise impacts from these construction activities.

4.4 Construction road traffic noise

Vehicle movements on public roads associated with construction of the pipeline, including the temporary laydown areas at the Tomago section, would be largely generated through the initial delivery of plant, equipment and materials.

These vehicles would generally be using the same roads as for the approved pipeline and anticipated traffic generation is unchanged. Accordingly, potential construction-related road traffic noise generation is unchanged from the predictions in the 2009 study for the approved project. The relevant assessment criteria are unchanged by introduction of the RNP.

Therefore, it is concluded that the proposed modification will not change the road traffic noise assessment results from those reported by Atkins (2009) for the approved project. In summary, the 2009 assessment reported that traffic volumes generated during GGP construction would be minimal compared to background road traffic volumes and the relevant criteria would be satisfied. Therefore, construction traffic noise is predicted to comply with the relevant criteria outlined in Section 3.4.

4.5 Construction vibration

The 2009 study identified that the main source of ground vibration would be use of rock hammers. The proposed modification does not involve any change to vibratory activities and so the 2009 vibration assessment results are unchanged by the proposed modification. In summary the 2009 study predicted that rock hammer use could result in ground vibration levels up to 0.5 mm/s at a distance of 20 m and would be below 0.3 mm/s at 40 m. Vibration levels at these distances satisfy the guidelines to protect against structural damage (Table 3.12) and are expected to be acceptable from a human comfort perspective (refer to Chapter 3).

The 2009 study recommended that rock hammers not be used within 20 m of a residence. Accordingly, this measure was included in AGL's commitments for the pipeline component of the GGP, in Chapter 26 of the AECOM (2009) EA.

4.6 Construction blasting

The 2009 study identified that confined blasting may be required during construction, for example to remove rock outcrops. Blast holes would be drilled and filled with an explosive charge and detonated with the aid of primers and detonators. There is no change to this as a result of the proposed modification and so the 2009 blasting assessment results are unchanged by the proposed modification. The outcomes are reproduced here for ease of reference.

Impacts associated with blasting normally relate to air blast overpressure and ground vibration.

The 2009 study predicted air blast overpressure for a range of maximum instantaneous charges (MICs) at various offset distances. It was predicted that the ANZECC (1990) air-blast overpressure goal (115 dBLin) could be satisfied with the employment of controlled MIC (1-3kg) at a distance of 200 m.

The 2009 study also predicted ground vibration for a range of MICs at various offset distances. It was predicted that the ANZECC (1990) ground vibration goal (5 mm/sec) would be satisfied with the employment of controlled MICs (1-3 kg) at a distance of 200 m. These assessment parameters are considered to be conservative, as ground vibration levels generally require less stringent limits than air-blast overpressure limits.

The 2009 study recommended blasting not be undertaken within 200 m of a residence. Accordingly, this measure was included in AGL's commitments for the pipeline component of the GGP, in Chapter 26 of the AECOM (2009) EA.

5 Operational noise impacts

5.1 TRS operation

5.1.1 Assessment approach

The operation of the TRS would be consistent with that assessed and approved for the HDS. The operational noise limits specified in Condition 3.22 of the Project approval for the HDS at Hexham, are not relevant to the proposed TRS at Tomago, which has a different ambient noise environment. Updated criteria have been developed as part of this assessment (refer Section 3.3).

Operational noise associated with the TRS would depend on design factors including the number of process trains, gas flow pressure and velocities, valve types, pipe sizes and the location of bends and valves. Quantification of potential operational noise impacts associated with the TRS was completed using the same methodology as the 2009 assessment of the HDS. A noise model was developed based on the indicative TRS layout depicted in Figure 2.8 of the EA main report and sound power level information outlined in the 2009 study. As the TRS design is yet to be finalised, detailed noise controls have not yet been determined and so the emission levels conservatively assume no noise controls. These will be finalised during its detailed design.

The TRS will operate under the same flow conditions and experience the same meteorological conditions as the previously approved HDS. Therefore several scenarios have been assessed for the TRS operation incorporating three-dimensional digitised ground contours in the vicinity of the TRS and based on preliminary operating conditions and meteorological data outlined in the 2009 study.

Noise levels were predicted using Brüel and Kjær Predictor Version 8.14 noise modelling software, using the same algorithm as used in the 2009 study. It was conservatively assumed that all equipment will be operational at one time and at full power. The noise predictions are therefore considered conservative.

As mentioned previously, AGL has already committed to a range of management measures to address potential noise impacts from the GGP's operation, including the formerly-proposed HDS, many of which will also be applied to the TRS. These are included in the conditions of Project approval and are discussed in Chapter 6. Measures include an Operation Environmental Management Plan (OEMP) that prescribes measures for monitoring and management of noise emissions, a community and stakeholder engagement plan and a complaints procedure.

5.1.2 Noise sources

Table 5.1 presents typical TRS operating equipment and plant and their sound power levels under high and low flow rate conditions. This information was sourced from the 2009 study for the HDS.

Table 5.1 Operational noise source – TRS

Plant	SWL, dB(A)	
	High flow rate	Low flow rate
Water bath heater 1	120	93
Water bath heater 2	120	93
Dry gas filters	122	72
Meters	120	93

Table 5.1 Operational noise source – TRS

Plant	SWL, dB(A)	
	High flow rate	Low flow rate
Flow control stage 1	102	97
Flow control stage 2	110	105

Source: Atkins (2009).

The location of the proposed odourant facility has not been finalised at this stage, with two options being considered, either within the TRS or inside the NGSF boundary. Both options are within approximately 40 m of each other and will receive shielding effects from nearby NGSF structures. Therefore potential noise impacts from either option are considered to be comparable for the purpose of this assessment.

5.1.3 Meteorological conditions

The 2009 noise study undertook a detailed meteorological analysis for the local area, as part of its assessment for the HDS. The prevailing weather relevant to the proposed TRS location has also been considered in this assessment.

Noise modelling was undertaken for calm conditions (no wind or temperature gradient) and for prevailing meteorological conditions. Under various wind and/or temperature gradient conditions, noise levels may increase or decrease at a particular location compared to those experienced during calm conditions due to refraction caused by the change in the speed of sound with height above the ground. For example, noise levels at a receptor increase when the wind blows from source to receptor and/or under temperature inversion conditions.

Prevailing meteorological conditions that require assessment are the conditions defined in the INP that are a 'feature' of the area. A 'feature' is a condition that occurs at least 30% of the time in an assessment period and season. Based on the INP and the meteorological analysis conducted as part of the 2009 study, the relevant meteorological conditions for receptors in the vicinity of the TRS are presented in Table 5.2. It is noted that the 2009 study of the HDS also modelled a scenario of temperature inversion coincident with west north-westerly drainage flows. Based on the difference in elevation between the TRS and receptors, drainage winds are not considered applicable in accordance with the INP and so they have not been considered in this assessment.

Table 5.2 Modelled meteorological conditions – TRS operation

Scenario	Wind speed (m/s)	Wind direction	Temperature (°C)	Inversion
1 – calm	0	N/A	20	N/A
2	2	NE	20	N/A
3	2	N	15	N/A
4	2	WNW	15	N/A
5	0	N/A	15	2°/100m

5.1.4 Model results

The predicted noise levels at sensitive receptors associated with operation of the TRS are presented in Tables 5.3 and 5.4 for high and low flow conditions respectively.

Once operational the TRS will operate continuously, therefore noise levels have been quantified for day, evening and night-time periods.

Table 5.3 Predicted TRS operational noise levels to receptors – high flow rate

Receptor	Criteria, dB(A)[1]			Predicted noise levels, $L_{eq(15\text{-}min)}$, dB(A)				
	Day	Evening	Night	Meteorological condition				
				1	2	3	4	5
R37. 9 School Drive	51	49	49	40	42	45	43	42
R38. 45 School Drive	51	49	49	38	42	46	45	43
R39. 5 Graham Drive	47	44	42	32	30	37	39	38
R40. Hunter Region Botanic Gardens	50	50	50	46	43	42	44	46
R41. Caravan Park	55	53	51	<30	34	<30	<30	33
R42. Historic Tomago House	50	50	50	35	39	43	43	41

Notes: 1.Day is the period from 7 am to 6 pm Monday to Saturday or 8 am to 6 pm on Sundays and public holidays. Evening is the period from 6 pm to 10 pm, night is the remaining periods.

Table 5.4 Predicted TRS operational noise levels to receptors – low flow rate

Receptor	Criteria, dB(A)[1]			Predicted noise levels, $L_{eq(15\text{-}min)}$, dB(A)				
	Day	Evening	Night	Meteorological condition				
				1	2	3	4	5
R37. 9 School Drive	51	49	49	<30	<30	<30	<30	<30
R38. 45 School Drive	51	49	49	<30	<30	<30	<30	<30
R39. 5 Graham Drive	47	44	42	<30	<30	<30	<30	<30
R40. Hunter Region Botanic Gardens	50	50	50	<30	<30	<30	<30	<30
R41. Caravan Park	55	53	51	<30	<30	<30	<30	<30
R42. Historic Tomago House	50	50	50	<30	<30	<30	<30	<30

Notes: 1.Day is the period from 7 am to 6 pm Monday to Saturday or 8 am to 6 pm on Sundays and public holidays. Evening is the period from 6 pm to 10 pm, night is the remaining periods.

The predicted noise levels in Tables 5.3 and 5.4 indicate that the operational noise levels associated with the TRS will comply with the relevant criteria for all periods and operating conditions at all assessed receptors for both low and high flow conditions. This is an improvement when compared with the HDS at Hexham, which was closer to sensitive receptors and predicted to result in some criteria exceedances.

5.2 Sleep disturbance - TRS operation

Due to the continuous nature of anticipated TRS noise sources, no intermittent noise events that could result in sleep disturbance impacts are anticipated during its operation. Consistent with findings of the 2009 study, it is considered that operational $L_{A1,1min}$ noise levels from the TRS would not be greater than 5-10 dB(A) above the operational L_{eq} levels. As sleep disturbance criteria are generally set at 15 dB(A) above operational L_{eq} criteria it is considered that the EPA's sleep disturbance criteria will be satisfied.

5.3 Cumulative operational noise

A cumulative assessment was completed considering existing industrial noise sources in the area combined with anticipated future operating noise from the approved NGSF and proposed TRS. Data on existing industrial noise levels and predicted NGSF operating noise was sourced from Atkins (2011). The impacts were assessed with reference to relevant amenity criteria in the INP.

Several scenarios were assessed based on worst-case INP-assessable meteorological conditions for each receptor. Source-to-receptor winds and inversion conditions present the worst-case meteorological conditions at receptors south of the TRS (R37-R39 and R42), and source-to-receptor winds present the worst-case assessable meteorological conditions at the Hunter Region Botanic Gardens and Tomago Village Caravan Park.

Existing industrial L_{eq} noise contributions of 38 dB(A) at 5 Graham Drive and 43 dB(A) at School Drive receptors and the Tomago Caravan Park were adopted, consistent with findings of the 2009 assessment.

The results of the cumulative noise assessment under high flow conditions at the TRS are presented in Table 5.5 for a hypothetical unmitigated scenario.

Table 5.5 Cumulative noise assessment at sensitive receptors – high flow TRS

Receptor	Criteria, dB(A)[3]			Predicted noise levels, $L_{eq(15\text{-}min)}$, dB(A)[4]			
	Day	Evening	Night	TRS – high flow	NGSF[1]	Industrial L_{eq}[1]	Total cumulative noise L_{eq}
R37. 9 School Drive	60	50	45	45	20[2]	43	**47**
R38. 45 School Drive	60	50	45	46	20	43	**48**
R39. 5 Graham Drive	60	50	45	39	24	38	42
R40. Hunter Region Botanic Gardens	50	50	50	46	40	N/A	47
R41. Caravan Park	60	50	45	34	19	43	44
R42. Historic Tomago House	50	50	50	43	20[2]	43[2]	44

Notes: *1. Source: Atkins (2009).*

2. Adopted value from adjacent 45 School Drive receptor.

3. Day is the period from 7 am to 6 pm Monday to Saturday or 8 am to 6 pm on Sundays and public holidays. Evening is the period from 6 pm to 10 pm. Night is the remaining periods.

4. Predicted noise levels are for the worst-case meteorological conditions at each receptor.

5. Bold font indicates exceedance of the night criteria.

The results in Table 5.5 indicate that during high flow TRS operating conditions (unmitigated) in the night and concurrent worst case INP-assessable meteorological conditions (temperature inversion and prevailing source-to-receptor winds), cumulative noise is predicted to exceed the criteria by up to 3 dB(A) at School Drive receptors (R37 and R38). There is a relatively low likelihood of concurrent occurrence of all the conditions required for the criteria exceedance to occur. Noise management and mitigation measures are discussed in Chapter 6. As an indication, a noise level increase of 1 to 2 dBA is not noticeable.

Cumulative noise levels are expected to comply with relevant INP amenity criteria at all other assessed sensitive receptors for all assessed conditions and periods.

The results of the cumulative noise assessment under low flow conditions at the TRS are presented in Table 5.6.

Table 5.6 Cumulative noise assessment at sensitive receptors – low flow TRS

Receptor	Criteria, dB(A)[3]			Predicted noise levels, $L_{eq(15\text{-}min)}$, dB(A)[4]			
	Day	Evening	Night	TRS – low flow	NGSF[1]	Industrial L_{eq}[1]	Total cumulative noise L_{eq}
R37. 9 School Drive	60	50	45	25	20[2]	43	43
R38. 45 School Drive	60	50	45	26	20	43	43
R39. 5 Graham Drive	60	50	45	19	24	38	38
R40. Hunter Region Botanic Gardens	50	50	50	26	40	N/A	40
R41. Caravan Park	60	50	45	14	19	43	43
R42. Historic Tomago House	50	50	50	23	20[2]	43[2]	43

Notes: *1. Source: Atkins (2009).*

2. Adopted value from adjacent 45 School Drive receptor.

3. Day is the period from 7 am to 6 pm Monday to Saturday or 8 am to 6 pm on Sundays and public holidays. Evening is the period from 6 pm to 10 pm. Night is the remaining periods.

4. Predicted noise levels are for the worst-case meteorological conditions at each receptor.

The results in Table 5.6 indicate that cumulative noise levels are expected to comply with relevant INP amenity criteria for all assessed conditions, periods and locations, during low flow conditions at the TRS.

5.4 Operational road traffic

Anticipated traffic generation associated with operation of the TRS and pipeline is unchanged from the predictions in the 2009 study for the approved project. The relevant assessment criteria are unchanged by introduction of the RNP. Therefore, it is concluded that the proposed modification will not change the road traffic noise assessment results from those reported by Atkins (2009) for the approved project. In summary, the 2009 assessment reported that traffic volumes generated during GGP operation would be minimal compared to background road traffic volumes and the relevant criteria would be satisfied. Therefore, road traffic noise during operations is predicted to comply with the relevant criteria outlined in Section 3.4.

5.5 Pipeline operation

As for the approved project, any noise generated by the operating pipeline as part of normal operations would generally be negligible and would have negligible potential for any impact, including for sleep disturbance. Operational activities would not include any vibratory activities such as blasting which could have impacts. This is consistent with the findings of the 2009 study and accordingly an operational noise assessment is not required for the proposed pipeline modification.

It is noted that in the event of an emergency necessitating depressurising of the pipeline, natural gas could be vented via the pipe (vent line) that runs from the MLV to the remote vent, anticipated to be within the Seaham section. Emergency venting and associated noise impacts would be short-term and temporary. Noise associated with venting may occur over a period exceeding 15 minutes (potentially in the order of an hour or more, based on industry information).

While it is likely that this would be audible at nearby sensitive receptors, emergency venting would be very infrequent and is atypical to standard operating conditions. It would be unavoidable, required in an emergency to prevent significant operational failure and necessary for public safety and other reasons. Specific noise limits would not apply to this activity. No additional noise management or mitigation measures are required with respect to the MLV facility.

6 Management and monitoring

The noise and vibration assessment results are generally consistent with those presented in the original AECOM (2009) EA for the approved project. No additional noise or vibration impacts were identified in association with the proposed modified construction or operating activities.

The existing approved measures are considered suitable for the proposed modification and no additional management or monitoring measures are required. The only modifications required to the existing Project approval conditions in respect of noise and vibration is removal of measures applicable to the HDS, including operating noise limits, and insertion of limits applicable to the TRS.

Project approval Condition 3.24 requires development of a detailed design noise report in consultation with DECCW (now EPA) to confirm the predicted noise levels associated with the HDS at sensitive receptors. This was partly in response to criteria exceedances predicted during HDS operation. Provided the TRS is generally constructed and operated as described previously, an equivalent measure is not considered necessary for the TRS, which is further from sensitive receptors than the HDS. Operating noise from the TRS is predicted to generally comply with the relevant criteria, even with the highly conservative modelling assumptions applied.

When considering cumulative noise from existing industry and the approved NGSF, and conservative unmitigated predictions from the proposed TRS, minor (up to 3 dBA) exceedances of the criteria are predicted at residences on School Drive. However these exceedances are limited to worst-case assessable meteorological conditions in the night and high flow operations at the TRS. Conditions 4.3 and 4.4 of the Project approval include provisions for a monitoring program to confirm the noise emission performance of the GGP and determine any associated requirement for remedial measures. These conditions are considered to be appropriate for the TRS.

It is considered that the noise and vibration impacts associated with the proposed modification can be effectively managed by compliance with the existing Project approval conditions, which include:

- prescribed construction hours for gas transmission pipeline construction works that would generate audible noise at any sensitive receptor (Condition 3.14) and for blasting (Condition 3.15). Written approval of the Director-General is required for any variation to these construction hours and is subject to consultation and notification for surrounding receptors and provision of all reasonable and feasible measures identified to minimise noise impact and the other details specified in Condition 3.16;

- implementing all reasonable and feasible measures to minimise noise generation from the construction of the project consistent with the requirements of the Interim Construction Noise Guideline (DECC 2009), including noise generated by heavy vehicle haulage and other construction traffic associated with the project (Condition 3.17);

- noise monitoring to confirm the noise emission performance of the project (Condition 4.3) with remedial measures implemented if required (Condition 4.4);

- complaints procedure (Condition 6.2 and 6.3);

- community and stakeholder engagement plan (Condition 6.5);

- a CEMP including measures to monitor and manage noise, vibration and blasting impacts (Condition 7.2(g));

- development of an OEMP including measures to monitor and manage noise emissions (Condition 7.4(eiii));

- ensuring that blasting from the project does not exceed the preferred values for vibration outlined in the ANZECC (1990) guideline, *Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration* (Condition 3.18)

- ensuring that ground vibration from the project does not exceed the preferred values for vibration outlined in the ANZECC (1990) *Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration* (Condition 3.19), and that prior to each blasting event, relevant local councils and potentially affected landowners are notified (Condition 3.20); and

- ensuring that vibration from the project does not exceed the preferred values for vibration outlined in *Assessing Vibration : A Technical Guideline* (DEC 2006) (Condition 3.21).

Specifically, Condition 7.2(g)ii requires :

> identification of all reasonable and feasible measures proposed to be implemented to minimise construction noise and vibration impacts (including construction traffic noise impacts), measures for notifying surrounding receptors of noisy activities or works outside of standard hours, measures for monitoring compliance and responding to complaints and contingency strategy in the case that project related vibration or blasting results in damage to buildings or structures.

Consistent with findings of the 2009 study, given that no significant noise sources were identified in association with the proposed operation of the pipeline, other than short-term emergency venting, no mitigation measures are required in respect of the pipeline's operation.

The Project approval (Condition 1.1) also requires the GGP be carried out in accordance with the AECOM (2009) EA which includes the following additional requirements that would also need to be applied to the modified project:

- no use of rock hammers within 20 m of a residence; and

- no blasting to be undertaken within 200 m of a residence.

7 Conclusion

EMM has completed a noise and vibration assessment of the proposed modification. The assessment results are generally consistent with those in the original AECOM (2009) EA for the approved project. No additional noise or vibration impacts were identified in association with the proposed modification. This is as expected given that:

- the proposed construction and operating activities for the realigned sections of pipeline and the TRS are generally unchanged from those described in the AECOM (2009) EA for the approved pipeline and HDS, respectively; and

- sensitive receptor offset distances from the proposed pipeline corridor realignments are generally within the range identified in the AECOM (2009) EA for the approved pipeline corridor.

Consistent with predictions in the 2009 study, short-term construction activities within the modified pipeline corridor alignment and at the TRS are predicted to result in criteria exceedances at the closest sensitive receptors. These temporary, short-term impacts can be appropriately managed by the existing approved management measures in the AECOM (2009) EA and Project approval conditions.

No significant noise sources were identified in association with the proposed pipeline operation, other than short-term emergency venting at the MLV facility. Venting would generate noise however this would be infrequent, temporary and short-term.

Operating noise from the TRS is predicted to comply with the relevant criteria for all periods and operating conditions at all sensitive receptors. This is an improvement when compared with the HDS at Hexham, which was closer to sensitive receptors and predicted to result in some criteria exceedances. When considering cumulative noise from existing industry and the approved NGSF, and conservative unmitigated predictions from the proposed TRS, minor (up to 3 dBA) exceedances of the criteria are predicted at residences on School Drive. These exceedances are limited to worst-case assessable meteorological conditions in the night and high flow operations at the TRS. The existing Project approval conditions include provisions for validation monitoring to confirm noise emission performance and determine any associated requirement for remedial measures. These measures are considered appropriate for the TRS. Operation of the TRS is not anticipated to have any sleep disturbance impacts.

The proposed modification is not expected to result in any material change to traffic generation during construction or operations and so would not change the road traffic noise assessment results or conclusions from those in the AECOM (2009) EA.

The proposed modification does not involve any change to proposed vibratory or blasting activities and so the 2009 vibration and blasting assessment results are unchanged. Based on these results, the AECOM (2009) EA included commitments that there be no use of rock hammers within 20 m of a residence and no blasting within 200 m of a residence.

In summary, the noise and vibration assessment results are generally consistent with those in the original AECOM (2009) EA for the approved project and can be appropriately managed and mitigated through the measures set out in the AECOM (2009) EA and Project approval (PA 08_0154). The only modifications required to the existing Project approval conditions in respect of noise and vibration is removal of measures applicable to the HDS, including operating noise limits, and insertion of limits applicable to the TRS.

References

AECOM 2009, *Gloucester Gas Project Environmental Assessment* report prepared for AGL Pty Limited.

Atkins 2009, *Operation and Construction Noise Assessment - Gloucester Gas Project.*

Atkins 2011, *Construction and Operation Noise Assessment Noise and Vibration Assessment – Newcastle Gas Storage Facility Project.*

Australian and New Zealand Environment Conservation Council (ANZECC) 1990, *Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration.*

Australian Standard AS1055-1997, *Description and Measurement of Environmental Noise*.

British Standard BS 6472 – 2008*, Evaluation of human exposure to vibration in buildings (1-80 Hz).*

Department of Environment and Conservation NSW (DEC) 2006, *Assessing Vibration: A Technical Guideline.*

Department of Environment and Climate Change (DECC) 2009, *Interim Construction Noise Guidelines* (ICNG).

Department of Environment, Climate Change and Water (DECCW) 2011, *NSW Road Noise Policy* (RNP).

Environment Protection Authority (EPA) 1999, *Environmental Criteria for Road Traffic Noise*.

EPA, 2000, *NSW Industrial Noise Policy* (INP).

German Standard DIN 4150 – 1999-02, *Structural vibration, Part 3: Effects of vibration on structures*.

Appendix A

Glossary of Acoustic Terms

Table A1 Glossary of acoustic terms

Term	Description
ABL	The assessment background level (ABL) is defined in the INP as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured L_{90} statistical noise levels.
dB(A)	Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear.
ICNG	Interim Construction Noise Guideline
INP	Industrial Noise Policy
L_1	The noise level exceeded for 1% of the time.
L_{10}	The noise level which is exceeded 10% of the time. It is roughly equivalent to the average of maximum noise level.
L_{90}	The noise level that is exceeded 90% of the time. Commonly referred to as the background noise level.
L_{eq}	The energy average noise from a source. This is the equivalent continuous sound pressure level over a given period. The $L_{eq(15min)}$ descriptor refers to an L_{eq} noise level measured over a 15-minute period.
L_{max}	The maximum root mean squared sound pressure level received at the microphone during a measuring interval.
RBL	The Rating Background Level (RBL) is an overall single value background level representing each assessment period over the whole monitoring period. The RBL is used to determine the intrusiveness criteria for noise assessment purposes and is the median of the ABL's.
Sound power level (Lw)	A measure of the total power radiated by a source. The sound power of a source is a fundamental property of the source and is independent of the surrounding environment.

It is useful also to have some appreciation of the scale of decibels, the unit of noise measurement. The following gives some practical indication as to what an average person perceives about changes in noise levels:

- differences of less than approximately 2 dB are imperceptible in general, ie, most people would find it difficult to discern which is the louder of two noise sources having levels within 2 dB of each other; and
- a difference in noise levels of around 10 dB appears as either doubling or halving of loudness.