APPENDIX G2

ARROW BOWEN PIPELINE – ENVIRONMENTAL MANAGEMENT PLAN

OUTLINE BLAST NOISE AND VIBRATION MANAGEMENT PLAN

THIS PAGE INTENTIONALLY LEFT BLANK

Contents

Tables

Figures

Glossary

Term	Description
Airblast	The maximum noise level in dB Linear Peak due to a blast measured anywhere on a sensitive site which is located at least 3.5m from any building or other acoustically reflective surface (other than ground).
Ground vibration	The level of vibration measured in the ground anywhere on a sensitive site. The measurement point should be at least the longest dimension of the foundations of a building or structure away from the building or structure if possible. If this is not possible, the site should be chosen to be as far from the building or structure as is practical.
Lin Peak	Linear Peak – the maximum level of air pressure fluctuation measured in decibels without frequency weighting. Frequency weightings are often applied to sound measurements to ensure the measured parameter is indicative of the level experienced by the human auditory system. Weighting is not applied to airblast measurements as much of the sound from an airblast is at inaudible frequencies.
PPV	Peak Particle Velocity – the highest instantaneous sum of velocity vectors (measured in millimetres per second, mm/s) of the ground movement caused by the passage of vibration.
Vibration	Vibration may be expressed in terms of displacement, velocity and acceleration. Velocity and acceleration are most commonly used when assessing structure borne noise or human comfort respectively. Vibration amplitude may be quantified as a peak value, or as a root mean squared (rms) value. Vibration amplitude can be expressed as an engineering unit value eg 1mms-1 or as a ratio on a logarithmic scale in decibels: ▪ vibration velocity level = 20 log (V/Vref) (dB) ▪ the preferred reference level, Vref, for vibration velocity = 10-9 m/s The Vibration Dose value (VDV) is also becoming an accepted measure of vibration, being the cumulative vibration level received over a continuous 8-hour or 16-hour period.

1 INTRODUCTION

1.1 Overview

This Outline Blast Noise and Vibration Management Plan is for the construction of the Arrow Bowen Pipeline (ABP). It is based on, and includes information provided in the Environmental Impact Statement (EIS) for this project.

The project consists of approximately 580km of pipeline, which will convey coal seam gas for subsequent export as liquefied natural gas, and associated above ground infrastructure. The purpose of the project is to deliver coal seam gas from Arrow Energy's gas fields in the Bowen Basin to a proposed Arrow Energy gas gathering hub in the Aldoga precinct of the Gladstone State Development Area for further transmission to Arrow Energy's proposed Arrow LNG Plant on Curtis Island.

The pipeline will be a buried steel gas transmission pipeline of up to 1,050mm in nominal diameter and consists of the ABP mainline and three lateral pipelines. The proposed pipeline route will commence at Red Hill, approximately 90km north of Moranbah in Central Queensland and will terminate at Arrow Energy's proposed gas gathering hub where it will join the Arrow Surat Pipeline, approximately 22km south west of Gladstone. The project overview is shown in Figure 1.1.

The project program is proposed as follows:

- Contract award: 2014 / 2015
- Commence pipeline construction: April 2016
- Commence pipeline commissioning: End 2017
- Commercial pipeline operation: 2017 / 2018

Blasting may be required to loosen in-situ rock in areas along the pipeline. An analysis of where rock blasting will occur will be confirmed during the detailed design stage. The charge mass of explosive required per hole per blast will be very limited as rock and overburden of only up to 2m deep and 1.6m wide will need to be loosened. Blasting from the construction along the proposed pipeline route is not likely to cause perceivable vibration levels at the sensitive receptors and will not exceed the airblast overpressure and ground vibration criteria. The blasting levels and times provided within the DERM Ecoaccess guideline, Noise and Vibration from Blasting (2006) will need to be considered for blasting undertaken as part of construction activities.

Should blasting be required, a condition survey will be conducted on any landholders properties within 100m of where blasting is to occur. Any blasting will be carried out in accordance with current practice standards with particular reference to Australian Standard (AS) 2187 - *Explosives - Storage, Transport and Use.*

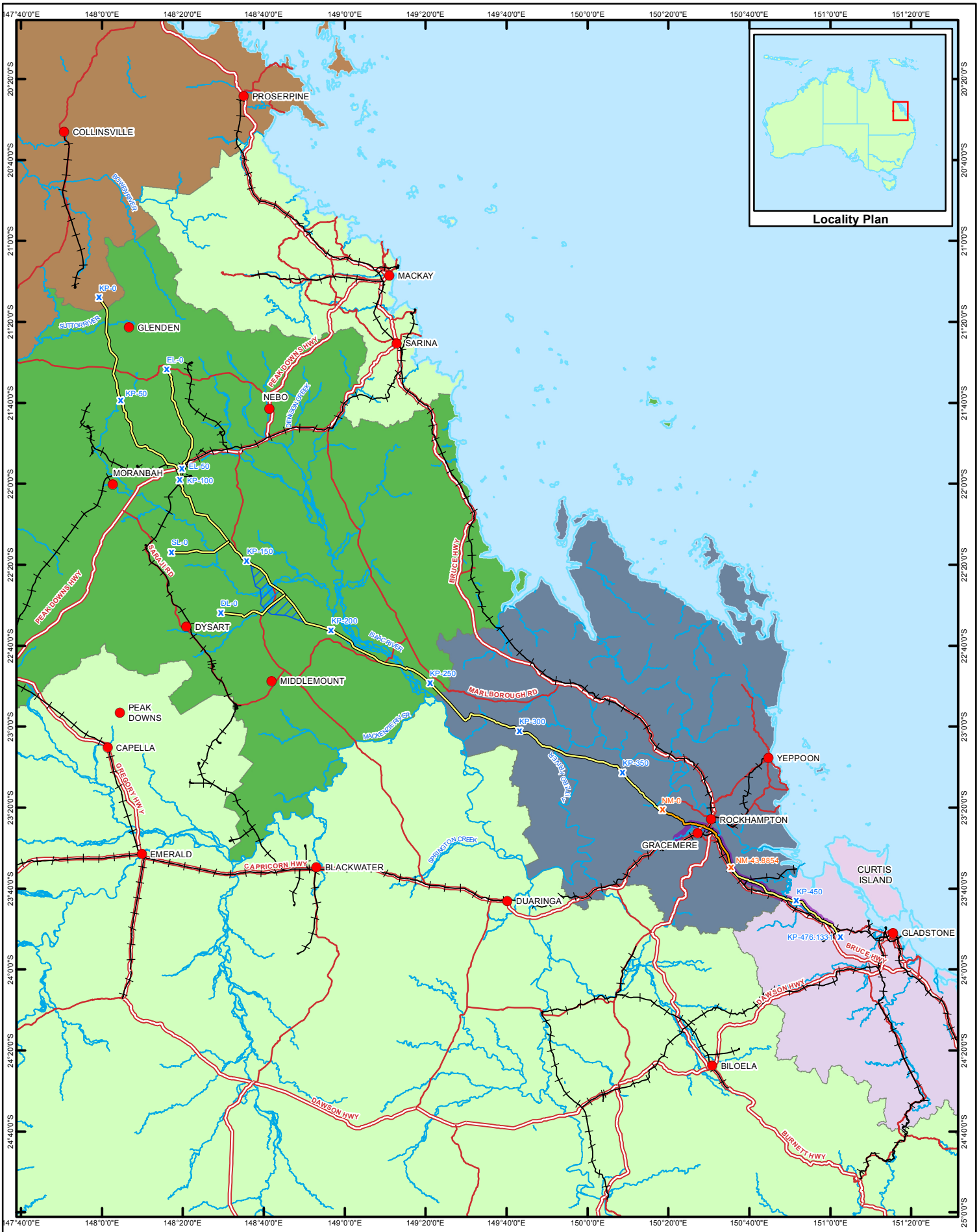

Figure 1 - 1: Overview of the pipeline route

Legend

- Major Towns
- Kilometre Point - ABP Route
- Kilometre Point - ABP Route SGIC Nine Mile
- ABP Route - Revision SR
- ABP Route - Revision SR SGIC Nine Mile
- Railways
- Highways
- Major Roads
- Major Watercourses
- Upper Isaac River Corridor
- Stanwell-Gladstone Infrastructure Corridor

Local Government Area 2011

- Gladstone Regional
- Isaac Regional
- Rockhampton Regional
- Whitsunday Regional

Data Sources:
StreetPro: Major Towns, Roads, Railways
DEHP: LGA, Major Watercourses
Data Supplied by Arrow Energy:
ABP Routes, Kilometre Points, Upper Isaac River Corridor, Stanwell-Gladstone Infrastructure Corridor

N

arrow energy go further

0 25 50 Kilometres

Scale: 1:2,250,000 @ A4
Coordinate System: GCS GDA 1994

Document: I:\QENV2\Projects\QE06591\EN0296.2.500 - Spatial\ArcGIS\EMP\Figure1_1_OverviewofThePipelineRoute_A4.mxd Date: 27/11/2012

1.2 Purpose and scope

This document contains a blast impact assessment and includes methods for undertaking over-pressure and vibration monitoring during blasting activities and for maintaining airblast and ground borne vibration impacts at a minimum.

1.3 Referenced standards and guidelines

Key environmental standards, guidelines and legislation relating to the management of potential blasting impacts include:

- ANZECC Technical Basis for Guidelines to Minimise Annoyance Due to Blast Overpressure and Ground Vibration
- German Standard DIN 4150 and British Standard BS 7385: Part 2 – 1993 for structural damage vibration
- British Standard BS 6472 and Australian Standard AS 2670 for human exposure to vibration
- Australian Standard AS 2187.2 Explosives – Storage, Transport and use Part 2: Use of Explosives.

2 ENVIRONMENTAL CRITERIA

2.1 Noise and vibration from blasting

Noise and vibration impacts associated with blasting during the construction phase are assessed with DERM's ecoaccess guideline, Noise and Vibration from Blasting (2006). These guidelines provide an assessment criterion for blasting noise and vibration as follows:

1) Noise

Blasting activities must be carried out in such a manner that if blasting noise should propagate to a noise sensitive place, then the air blast overpressure:

- must be not more than 115 dB (linear) peak for nine out of any ten consecutive blasts initiated, regardless of the interval between blasts
- must not exceed 120 dB (linear) peak for any blast.

2) Vibration

Blasting operations must be carried out in such a manner that if ground vibration should propagate to a noise sensitive place, the ground borne vibration:

- must not exceed a peak particle velocity of 5mm per second for nine out of any ten consecutive blasts initiated, regardless of the interval between blasts
- must not exceed a peak particle velocity of 10mm per second for any blast.

3) Times of blasting

Blasting should generally be limited to the hours of 9.00am to 3.00pm, Monday to Friday, and from 9.00am to 1.00pm on Saturdays. Blasting would not generally take place on Sundays or public holidays. Blasting outside these recommended times should be approved only where:

- blasting during the preferred times is clearly impracticable (in such situations blasts should be limited in number and stricter airblast overpressure and ground vibration limits should apply)
- there is no likelihood of persons in a noise-sensitive place being affected because of the remote location of the blast site.

Airblast overpressure levels received at a sensitive receptor from a blast are a function of several factors such as the charge mass and distance from the blast; burden depth; stemming height and meteorology.

Ground vibration experienced at a sensitive location from a blast is a function of several factors including the charge mass of explosive per hole, the distance from the blast and ground transmission characteristics. An approximation of the ground vibration variation with distance from the blast is provided by the following equation:

$$PPV = k\left(\frac{D}{\sqrt{m}}\right)^{e}$$

Where: PPV = peak particle velocity (mm/s)
m = charge mass per hole (kg)
D = distance from blast (m)
e = site exponent
k = site constant

3 DETAILS OF BLASTING

3.1 Proposed blast location

The Contractor is to identify the locations where blasting is to be undertaken.

3.2 Blasting methodology

The Contactor is to plan all blasts with consideration of the protection of people and property in the vicinity of the proposed blast. The Contractor will prepare a Blast Management Plan prior to each blast which will address potential risks and control measures. This plan will be prepared in accordance with Section 4 of AS 2187.2-2006 Australian Standard *Explosives – Storage and Use, Part 2: Use of Explosives*.

A separate Blast Management Plan shall be prepared by the Contractor for each individual blast in accordance with Section 4-3 of AS 2187.2-2006 Australian *Standard Explosives – Storage and Use, Part 2: Use of Explosives*.

3.3 Flyrock risk

Flyrock is often a result of under-burden or over-charging, and is the projection of rock pieces from the face of the blast. Flyrock from a face is most likely to be projected perpendicular to the face and least likely to be projected parallel to the face. The clearance distance design for blasts is relative to the maximum throw of flyrock, this will be calculated by the Blast Manager for the ABP and a suitable clearance distance determined around the site. The Contractor is to use minimum safety factors for plant and personnel are:

- the clearance distance for plant and equipment is double the maximum throw
- the clearance distance for personnel is four times the maximum throw.

3.4 Ground vibration

Vibration is generated at the moment of the blast and is transmitted through the ground. The effects of vibration can be divided into three main categories:

- inconvenience or disturbance of users of a building
- affecting the building contents
- affecting the integrity of the building or structure.

Vibration is measured by monitoring the movement of the ground through the three orthogonal axes, and producing a figure to represent the vector sum of this movement. The vibration levels at which human discomfort is perceived are well below the levels at which building damage may be caused. The main on site influences on ground vibration during a blast are as follows:

- Maximum Instantaneous Charge (MIC)
- delay interval
- direction of initiation
- charge confinement

- blast hole deviation
- geological conditions
- water saturation of ground.

In general terms, ground vibration increases with increased charge mass and reduces with distance.

3.5 Airblast overpressure

Air blast or overpressure is an air pressure wave that is generated by explosive movement of rock and gases at the triggering of a blast and is transmitted through the air. During a blasting event, the major influences on air blast levels include:

- delay interval
- burden
- spacing
- the amount and type of stemming used
- direction of initiation of the blast
- the charge depth
- covering of the detonation cord
- charge confinement
- blast hole deviation
- geological conditions
- meteorological conditions.

4 BLASTING ASSESSMENT

4.1 Blast sensitive receivers

The Contactor is to identify the nearest sensitive receivers to the proposed blast locations as outlined in Table 4.1.

Table 4.1: Nearest sensitive receivers to blast locations

Address	Receiver type	Distance to works (m)
TBC	TBC	TBC
TBC	TBC	TBC

4.2 Blast assessment

Specific blasting and seismic details will need to be assessed on a site and blast specific basis. It is important that the actual buffer zone distances, associated specifically with this project, be identified and appropriate measures taken to limit overpressure and vibration to acceptable levels at critical locations. Blast charge and blast configurations must therefore be selected to ensure that objectives outlined in Section 2 are not exceeded.

The Contractor is to undertake a series of trials at a reduced scale to determine site specific blast response characteristics, and ensure that the vibration and overpressure objectives can be met.

The distance limits relating to vibration and airblast overpressure set out in Table 4-2 have been determined using formula as outlined in Australian Standard 2187.2-1993, applicable to free-face blasting in 'average field conditions' which states:

Vibration formula:

and

$$V = 1140\left(\frac{R}{Q^{1/2}}\right)^{-1.6}$$

Overpressure formula:

$$OP = 165 - 24*(LogR - 0.33LogQ)$$

Where:

V = ground vibration as peak particle velocity in mm/s
R = distance between charge and point of measurement in metres
Q = effective charge mass per delay or maximum instantaneous charge in kilograms

The distance limits per nominated MIC may vary significantly depending on the geological conditions, local shielding and meteorological factors at the site.

It is important that blasting be monitored at the initial stages at critical locations surrounding the site to confirm predicted over-pressure and vibration levels and to in turn modify the blast design and buffer zones accordingly around the site.

The estimated effective mass charges to minimise annoyance are provided in Figure 4.1.

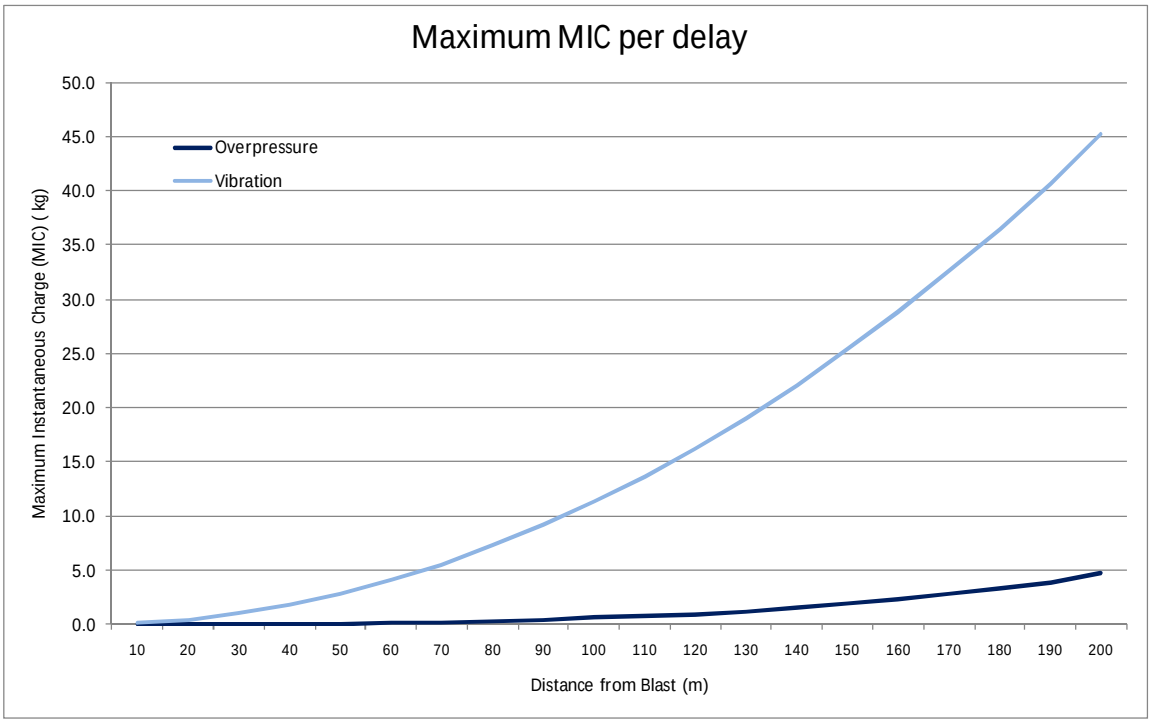

Figure 4.1: Estimated effective mass charges to minimise annoyance

The contractor is to determine the estimated effective mass charges to meet the blast criteria as follows.

Table 4.2: Estimated effective mass charges to meet blast criteria

Blast location	Nearest receiver	Distance (m)	Maximum Instantaneous Charge (MIC), kg	
			Airblast	Vibration
TBC	TBC	TBC	TBC	TBC

4.3 Blast management

The Contractor shall plan all blasts foremost with consideration of the protection of people and property in the vicinity of the proposed blast. This will be achieved through the preparation of a blast management plan prior to each blast which will address potential risks and control measures. This plan will be prepared in accordance with Section 4 of AS 2187.2-2006 Australian Standard *Explosives – Storage and Use, Part 2: Use of Explosives*.

A separate plan shall be prepared for each individual blast and shall address the following issues:

- Administration and legislation
- Safety and security
- Blast history and consultation
- Physical characteristics and geology
- Responsibilities
- Environmental impacts
- General safety precautions

- Special precaution
- Blast design.

Prior to the commencement of blasting at a location, a series of trials are to be undertaken at a reduced scale in conjunction with vibration and overpressure monitoring to determine site specific blast response characteristics, in order to define allowable blast sizes to occur within the criteria outlined in Section 2.

After each blast, performance should be reviewed and possible improvements implemented to ensure the safety of personnel and that an on-going good relationship is maintained with the community and the regulatory authorities. Appropriate action for the management of airblast overpressure and ground borne vibration impacts is summarised below in Table 4.3.

Table 4.3: Blast management actions

Action	Responsibility	Timing / frequency reference
Planning actions		
Blasting is to be avoided to the maximum extent practicable.	Construction Manager	Ongoing
Prior to the commencement of blasting at a location, a series of trials can be undertaken at a reduced scale to determine site specific blast response characteristics, in order to define allowable blast sizes to occur within the criteria outlined in Section 2.	Construction Manager	Per blast location
Blasting shall generally be undertaken between the hours of: ▪ 9.00am to 3.00pm Monday to Friday ▪ 9.00am and 1.00pm Saturday	Construction Manager	Per blast
Where blasting is to be conducted within 500m of any public road, these roads will need to be closed for the duration of the blast. This action may necessitate the preparation of a Road Closure Management Plan.	Construction Manager	Per blast
Community actions		
A minimum of 48 hours' notice shall be provided to all residences locate within 500m of any blast, including an indication of blasting times and a contact name and telephone number. The advice will be provided at least 5 days prior to any potential blast.	Community Liaison Officer	Per blast
Where any blasting is to occur within 500m of a sensitive receptor or a public road, at least 48 hours in advance of any proposed blasting operation, the contractor must provide: i. the proposed location and timing of the operation ii. the name of the person who will have control of the operation and evidence of his / her licence iii. documentary evidence of all necessary licence and permits from the relevant Authorities iv. precautions proposed to be taken for the protection of the public and property during the operation v. full details of explosives, blasting patterns and any other relevant information vi. methods of monitoring blast vibration vii. additional information required.	Blast Manager	Per blast
Where blasting is to occur within 200m of a sensitive receptor, monitoring of overpressure and vibration levels shall be undertaken for each blast.	Environmental Officer	Per blast

Action	Responsibility	Timing / frequency reference
Dilapidation surveys shall be undertaken for all buildings located within 200m of the road construction area prior to the commencement of blasting or major vibration inducing construction activities. The Contractor shall be responsible for rectifying any damages occurring as a result of the construction with the cost to be borne by the Contractor.	EPC Contractor	Per site
Technical actions		
Reduce the maximum instantaneous charge (MIC) to the lowest possible level by use of delays, reduced hole diameter, and/or deck loading.	Blast Manager	Per blast
Ensure stemming is adequate and eliminate exposed detonating cord. (eg cover with at least 300mm of quarry dust or road base or similar).	Blast Manager	Per blast
Eliminate secondary blasting. (Instead of popping, use rock breaker or drop hammer). Also make extra efforts to eliminate the need for toe shots, (e.g. better control of drill patterns).	Blast Manager	Per blast
Assess weather conditions at the time of the blast. Avoid heavy cloud cover, where possible, and avoid firing if a strong wind is blowing towards residences. In particular, avoid days of severe temperature inversion but if not possible blast between 11.00am and 1.00pm. Consider not loading a shot with explosives if the weather forecast is unfavourable.	Blast Manager / Construction Manager	Per blast
Exercise strict control over the spacing and orientation of all blast drill holes. Space holes in such a manner that the explosive force is just sufficient to break the stone to the required size.	Blast Manager	Per blast
Establish times of blasting to suit the situation, e.g. fire all blasts at a set time acceptable to nearby neighbours and preferably when background noise is highest.	Blast Manager / Environmental Officer / Community Liaison Officer	Per blast

4.4 Blast monitoring

4.4.1 Introduction

Blasting overpressure and vibration monitoring is to be undertaken during scheduled blasting trials to determine maximum allowable blasting sizes and for each blasting event to determine compliance with adopted air blast and ground vibration objectives.

4.4.2 Monitoring locations

Monitoring shall be undertaken at representative receivers located within 200m of the blast site, and at any other sensitive locations as required.

4.4.3 Test blasting

A series of small scale test blasting can be undertaken and monitored prior to commencement of actual blasting, to assist with estimating vibration and overpressure levels from actual blasting activities. Safe 'buffer zones' shall then be established based on predicted levels.

Blast monitoring shall also be carried out at the initial stages at critical locations surrounding the site to confirm predicted over-pressure and vibration levels and to in turn modify the blast design and 'buffer zones' accordingly around the site.

4.4.4 Monitoring procedures

For the purposes of checking compliance with the airblast overpressure and ground vibration conditions and for investigating complaints of noise and vibration annoyance, monitoring must be undertaken where any blasting occurs within 200m of a sensitive receiver.

Where access to a potential noise-affected property for monitoring purposes is not feasible, the measurement may be undertaken at the appropriate property boundary and the results extrapolated to reflect the impact at the receptor premises.

The proposed monitoring system for this project will include a portable near-field unit placed within close proximity to the blast area and up to three (3) additional blast monitoring units located at critical assessment locations.

The blast monitoring locations are to include areas within the surrounding community recognised as potentially sensitive or susceptible to blast impacts mostly because of their close proximity to the blasting. The monitoring locations to be considered shall be representative of the worst-affected premises surrounding the blast sites, and at a minimum include all residential properties within 200m of the blast site.

Measurement of airblast overpressure

Noise from blasting shall be measured using noise measurement equipment with a lower limiting frequency of 2Hz (- 3dB response point of the measurement system) and a detector onset time of not greater than 100µs as assessed in accordance with AS –1259.1 clauses 8.5 and 10.4.

Measurement of airblast overpressure should be taken at an appropriate location that is exposed to the direction of blasting and at least 4 m from any noise-affected building or structure or within the boundary of a noise sensitive place, at a position between 1.2m and 1.5m above the ground.

Blast monitoring instrumentation will be installed and maintained in accordance with relevant Australian Standards (e.g. AS2187.2 - 1993). Monitoring units should be calibrated annually to standards that are traceable to Australian Physical Standards held by the National Measurement Laboratory (CSIRO Division of Applied Physics).

Blast monitoring equipment generally consists of a computer and display unit connected by cable to a geophone transducer which senses vibration, and to a microphone with low-frequency measurement characteristics which senses air blast overpressure. Vibration and overpressure levels are monitored concurrently upon detection of a trigger, and the data is processed and stored in the computer memory. The operator may either retrieve the data at the conclusion of each monitoring period either in person or via a telephone modem if the logger is fitted with a mobile phone option.

4.4.5 Measurement of Ground Vibration

Vibration instrumentation must be capable of measurement over the range 0.1mm/s to 300mm/s with accuracy within 5% and have a frequency response flat to within 5% over the frequency range of 4.5Hz to 250Hz.

The ground-borne vibration transducer (or array) must be attached to a mass of at least 30kg to ensure good coupling with the ground where the blast site and the measurement site cannot be shown to be on the same underlying strata. The mass shall be buried so that its uppermost surface is at the same level as the ground surface.

The ground-borne vibration transducer (or array) must be placed at a distance of at least the longest dimension of the foundations of a noise-affected building or structure away from such building or structure and be positioned between that building or structure and the blasting site.

4.4.6 Monitoring Records

Blast monitoring records provide the data for determining any improvements in blast outcomes, including the management and control of ground vibration and airblast. A copy of these records should be included in the site blast records. As a minimum, blast monitoring records should include the following:

- the size of the blast, i.e. number of blast holes and quantity of explosives in each blast hole (MIC)
- the method of initiation and the timing sequence to be used in the blast
- the date and time of the blast
- the location of the measurement transducers (geophones, accelerometers, microphones)
- instrument trigger-levels
- measurement equipment and operator details
- the location of the blast
- the location of any structures and/or persons who may be affected by the blast
- the measured ground vibration (PPV) and airblast values (dB(L) peak) including the peak particle velocity values for each of the triaxial components, a derived vector peak particle value
- weather conditions, especially temperature, wind speed and direction, cloud cover, relative humidity, and any other notable conditions such as rain
- any subjective information from the shot firer and any persons who may be affected by the blast
- location, date and time of recording.

4.5 Quality assurance

The measurement and reporting of airblast overpressure and ground vibration levels must be undertaken by a suitably qualified and experienced person.

5 COMMUNITY CONSULTATION AND COMPLAINTS MANAGEMENT

5.1 Community notification and consultation

Close community liaison will be maintained to ensure that local residents are aware of the times and durations when they may be affected by blasting noise and vibration. Active community consultation and the maintenance of positive relations with local residents will assist in alleviating concerns and minimise complaints.

Where blasting is conducted for the first time at a location, a dilapidation survey will be undertaken for all buildings located within 200m of the blast area, prior to the commencement of blasting.

In addition to the requirement of this plan, the following specific measures shall be undertaken during blast planning:

- A minimum of 48 hours' notice shall be provided to all residences located within 500m of any blast, including an indication of blasting times and a contact name and telephone number. The advice will be provided at least 5 days prior to any potential blast.
- At least 48 hours in advance of any proposed blasting operation, the contractor must provide:

  i. the proposed location and timing of the operation

  ii. the name of the person who will have control of the operation and evidence of his / her licence

  iii. documentary evidence of all necessary licence and permits from the relevant authorities

  iv. precautions proposed to be taken for the protection of the public and property during the operation

  v. full details of explosives, blasting patterns and any other relevant information

  vi. methods of monitoring blast vibration.

5.2 Complaints handling

A complaints management system is to be established. Complaints arising from blasting operations should be treated sensitively and in accordance with overall project complaints procedure outlined in Section 4.9 of the EM Plan.

6 REFERENCES

Arrow Energy Pty Ltd, 2012. Arrow Bowen Pipeline Project - Environmental Impact Statement.

Chenoweth EPLA and Bushland Restoration Services, 2012. South East Queensland Ecological Restoration Framework: Guideline. Prepared on behalf of SEQ Catchments and South East Queensland Local Governments, Brisbane.

DERM, 2010. Preparing an EM Plan for CSG activities – Guideline, Department of Environment and Resource Management.

Ecosure, 2012. Arrow Bowen Pipeline Flora Assessment for Revision SR.

EcoSM, 2012. Arrow Bowen Pipeline Supplementary Report. Terrestrial Vertebrate Fauna Assessment, Ecological Survey & Management.