

# Bowen Gas Project

## Community information sessions 4-7 June 2012

### Introduction

In June 2012 Arrow Energy held a series of community information sessions in the Bowen Basin to introduce the community to its Bowen Gas Project.

Questions and answers were captured by JTA Australia and are presented in this document. Questions varied across the four sessions; to ensure that valuable information is shared throughout the communities, these notes summarise the discussions across all sessions.

The information sessions were held from 4 to 7 June 2012 at:

- Dysart, 4 June 2012
- Moranbah, 5 June 2012
- Middlemount, 6 June 2012
- Blackwater, 7 June 2012

Arrow is seeking to develop opportunities for the supply of gas to new export markets, including a proposed LNG development at Curtis Island near Gladstone. As part of this work, Arrow is undertaking an environmental impact statement covering the area of its proposed Bowen Gas Project which extends from Glenden in the north, to Blackwater in the south.

### How to read these notes

Questions and comments from the audience are in bold type. The unbolded responses are from Arrow staff.

In some cases responses have been summarised and at other times additional information has been included to provide further context or explanation; this information is italicised following the answer.

If you have any further questions or comments about the project, the meeting notes or if you would like detailed maps of the exploration areas, please contact the project team:

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**Acronyms**

ATP	Authority to prospect
BTEX	benzene, toluene, ethylbenzene, and xylene
CSG	coal seam gas
DEHP	Department of Environment and Heritage Protection
DERM	Department of Environment and Resource Management
EA	environmental authority
EIS	environmental impact statement
FID	final investment decision
LNG	liquefied natural gas
MPa	Megapascals
psi	pounds per square inch
PL	petroleum lease
QGC	Queensland Gas Company
QWC	Queensland Water Commission
RO	reverse osmosis
RPM	revolutions per minute
SIS	surface to in-seam (drilling)

**Conversions**

1 kilolitre (KL) = 1,000 litres

1 megalitre (ML) = 1,000,000 litres

1 gigalitre (GL) = 1,000,000,000 litres

**Queensland Government Acts mentioned:**

*Acquisition of Land Act 1967 (QLD)*

*Environmental Protection Act 1994*

*Mineral Resources Act 1989*

*Petroleum and Gas (Production and Safety) Act 2004*

*Water Act 2000*

*Water Supply (Safety & Reliability) Act 2008*

**Dysart**

Date:	4 June 2012	
Venue:	Queensland Mines and Rescue Service, Dysart	
Presenters:	Carey Bradford, Exploration Manager South	Arrow Energy
	Fergal Convery, Bowen Gas Project EIS Project Manager	Arrow Energy
	Melita Keast, Principal Community Relations	Arrow Energy
Facilitator:	Jan Taylor, Principal	JTA Australia

- 1. First off, as landowners we don't want you here anyway. By law we have to accept you. Don't make the mistake they made on the pipeline down from the Surat Basin to Gladstone, they came out and said all landholders voluntarily agreed with the pipeline going through their places. In reality they were told they could either toe the line or they'd be taken to the Land Court.**

Sorry, which company are you talking about?

**I don't think it was Arrow, it was Queensland Gas. It really angered the landholders down there. QGC made it look all fuzzy in the media. Nothing gets people wilder than that, so I urge you not to go down that path, all of this is under sufferance.**

- 2. How are you going to keep all these weeds out that are going around in the area? Sarina is now full of Giant Rat's Tail grass. You'll have employees living in Sarina, driving out from Sarina. How are you going to keep it out of this area?**

We try our best with wash downs. We have an obligation to keep coming back to sites to check we are rehabilitating properly; if there was any sort of outbreak then it would be on us to spray the weeds.

- 3. The Giant Rats Tail grass can lie dormant in the ground for ten years. That's a long time to follow up. If people are coming out of those Giant Rat's Tail grass areas, the vehicles from there shouldn't be allowed to come onto a clean property. They should go to a central point and then use another vehicle which is clean. We're getting coal miners coming around at the moment, and they come from Sarina which is full of it. They say they have cleaned their vehicles but I just don't think that is good enough.**

We don't let our employees take vehicles home. I'm from Sarina myself actually so when I drive in and out I drive my private car; I leave it at the camp and am allocated a company car from there. That car would generally stay in the district and be subject to wash downs very regularly. But yes, we know we can only do our best with the wash downs. There is that follow up process.

In addition, Arrow has employed a pest and weed specialist to develop weed management policies because we have an obligation under the legislation to manage the weeds. We have employed this person to develop processes to minimise the risk. Personal vehicles are left at the base in Moranbah, and company vehicles can be washed down two or even three times a day as they go through different properties. We also have to put most of our people through wash down training as well.

- 4. It is a big issue because when they put that first pipeline through to Gladstone they spread Parthenium from one end of the pipeline to the other. When they put the sprayer down to do the wash down they just had to drive through it again.**

What you are saying is true but I think we've come a long way in the last five years; as Carey was saying we train most of our employees to do a weed and seed identification and wash down process. As things move on I'm sure we'll improve even more. We do wash downs from property to property and we have portable wash down units that we are starting to take out onto the sites. We are now looking at putting more drilling camps in areas being worked so as to minimise the travel. Once they are on the site they stay there until they have finished their drilling, then they move the camp to the next site.

- 5. The DPI has a recommended way to clean vehicles now. Have you had a look at that information?**

That's what our people have been trained in.

- 6. DPI is using emulsifiable oils with new recommendations to spray on the radiator and around the chassis to kill the seeds so they can't blow out and germinate. Castrol farm cleanse I believe.**

I know we used to look at spraying down with diesel to stop the germination of the seeds but I don't know how good that is.

- 7. It does work.**

You also asked how long Arrow will take responsibility for the weeds etc around the pipeline?

- 8. Yes, and also when you come in and drill. I'm not complaining, but when you came onto my place and put three wells down, Woolly-Headed Rose Grass came up along the tracks to one well where we don't drive. We've got it in other paddocks but it just shows how stuff does spread.**

What you are saying is right, seeds can lay dormant in the ground for ten or fifteen years so they may have been there but we disturbed the soil, and activated or allowed them to germinate so we certainly have a responsibility to manage the infestations.

- 9. These only have a lifespan of about eighteen months; they probably dropped off a vehicle but they could have come from our place. I'm just saying how they can spread.**

We have an obligation to manage those sites for three to five years I think. We've got a long-term commitment to remedy any harm we create like weeds.

- 10. We've been involved with Arrow with a pipeline at the back of our place but we've also been involved with Queensland Gas. Some of the paperwork we've been getting from QGC also mentions Arrow. It's a bit confusing, what's the connection between Arrow and QGC? From what I'm led to believe this guy is not supposed to be putting these papers out and signing them on behalf of Arrow when he's actually QGC.**

There is some tenure we've inherited through the Pure Energy takeover. Pure Energy is a company Arrow and QGC fought over in a takeover. Prior to the takeover we had a buy-in option on Pure Energy as well and owned a part of that tenure, I believe it's a 50/50 split. Currently Arrow operates some of the tenure, we do the work programs; some of the other tenure is operated by QGC and it does the work programs. What we're working through with QGC right now is a division where QGC takes XYX tenement and Arrow takes ABC tenement so that there is a clear separation. At the moment it's very difficult to sign off on expenditure application, apart from the reputational issues involved as well. We're trying to make it perfectly transparent in the future. Hopefully in the next six to twelve months Arrow will have a land swap with QGC and there'll be a complete separation.

It's not uncommon for tenure to be held by more than one party. It happens a lot in the oil and gas industry, with oil particularly there could be six parties involved in the one tenure. We're trying to make it transparent and it's easier to do business when you're running the whole show.

**11. Has everyone affected by the proposed pipeline route been contacted yet?**

My understanding is that we will be talking to those people one-on-one through the land agents.

*All landholders along the pipeline route have been contacted.*

**12. So you've drawn the pipeline route but nobody has been contacted yet?**

Those people, several thousand in fact, should have been contacted already. Anyone who it was thought might have an interest or be affected in some way were invited to sessions out here earlier in the year. The land agents have also been meeting one-on-one with the people affected.

**13. So if we haven't been contacted it means it won't be on our property?**

I'm sorry but I can't be 100% sure; it is possible that contact hasn't yet been made. If you come to us afterwards and give us your details we can check on that.

*If you have not been contacted, then the pipeline will not be crossing your property.*

**14. Do you know what percentage of your workforce will be fly in fly out (FIFO)?**

We offer fairly significant financial inducement for our staff to move to Moranbah.

**15. Will that apply for Middlemount, Dysart or wherever you will be putting the pipeline through?**

The pipeline will be a transient workforce that comes and goes. It's only in one place for a short duration.

**16. How will they be housed?**

There will probably be three or four camps across the region.

**17. In one of those towns?**

Probably not even in a town as the towns can be quite far away from the pipeline. Our other field developments will be looked at individually. Some of the work e.g. drilling will generally be done on a fly in fly out basis due to the nature of the workforce but where possible we try to encourage people to move to the towns. Having said that, there will still be a certain amount of the workforce that are FIFO.

**18. So you can't really give a percentage on that then?**

Currently about 30% is residential and about 70% is FIFO.

**19. Will Moranbah be your main base? Will you have a group of people in Dysart as well?**

It does depend on how the fields develop – we're covering about 400km of the basin, so there will definitely be different centres while we work in different fields. It will have a lot to do with timing but we don't yet have a lot of detail. We've planned to try to work north and south but places like Dysart will be ideal; Middlemount and Blackwater too.

**20. Will you actually be able to find enough tradespeople to do the job?**

Typically the biggest workforce that we need will be around four to five thousand people in Gladstone while we are building the LNG plant there. There will be a much more modest workforce in this area, probably three to five hundred people in the long term. We should be fine with the majority of those jobs but people like petroleum engineers are very difficult to recruit in Australia. Typically the majority of our workforce is trainable.

**21. How are you going with your Kogan Project at the moment? I see it's on the news at the moment, cleaning up or something like that, there were people jumping up and down about it on the radio today.**

We're involved in some work at Kogan. I don't think the media story was about Arrow; there was certainly some adverse publicity over the weekend about Origin so that's what it might have been about. It also could have been about Santos in the Pilliga in NSW; it took over Eastern Star Gas and inherited a legacy of issues.

**Yes I think that was it.**

**22. If you're in full production what would be the maximum psi on the pipeline? What would be the exclusion zone if there was a pipeline failure? How long would it take to shut it down?**

The design of the pipeline that we are looking at is a maximum of 15 MPa (i.e. 15,000 kilopascals). Unfortunately I can't convert that to psi but hopefully that can give you some idea. We undertake a hazard and safety assessment as part of the EIS studies. We get a specialist to work with the development team and some of the engineers to work out various scenarios. That's a precursor to detailed hazard identification and hazard operability studies that we go through when we build anything at the design stage.

*Clarification following the information sessions confirmed that 15,000 kilopascals is equivalent to 2175 psi.*

**23. If there was a leak and your pipeline caught fire, what type of blast exclusion zone would be expected? What would the process and timeframe be for shutting that pipeline down?**

There are shutdown safety mechanisms along the length of the pipeline so if a leak is detected it blocks the pipe and isolates it. I'm sorry but I'm not sure of the exclusion zone, I will have to check on the details.

At a compressor station or facility, it would be a few hundred metres and that would be worked into the design of the facilities.

*The pipeline is managed through a Supervisory Control And Data Acquisition (SCADA) system via an optical cable buried with the pipeline. Mainline valves are located along the pipeline. The valves are also buried and the only above ground structures at these valves are a manual shut-off control. For a fire to occur, there would need to be a spark or some other mechanism to ignite the gas. This is why an easement is placed over the pipeline, in this case a 30m wide operational easement, and restrictions are placed on the easement so that a building or such related infrastructure could not be built over the pipeline. Where damage has been caused to a pipeline, this has been limited to third party activity, typically in built up areas. The only 'exclusion zone' refers to the above restriction in not placing any buildings or other such infrastructure over the pipeline within the 30m wide operational easement.*

**24. So what would be the distance of the closest residence to the pipeline?**

I'm sorry but I can't speak on behalf of the pipeline; that was a different EIS and different consultation process to this. Information on the Arrow Bowen Pipeline EIS is available on the Arrow website: [www.arrowenergy.com.au](http://www.arrowenergy.com.au). We can take the question on notice – we just don't have a pipeline person with us here today.

*Clarification following the information session confirmed that the closest house to the pipeline is 90m away.*

**25. I saw that when you bury the pipeline it could be 750mm from the surface. In these areas it probably needs to be a bit deeper because we have rippers and dozers that go down a metre. As there are so many dozers around that go to that sort of depth you might want to look at that.**

I can't be specific about the Arrow pipeline but I have quite a lot of experience generally in pipelines. In agricultural areas pipeline contractors will design the pipeline to suit and bury it at a depth which is below the levels you rip at. That's what we've historically done with pipelines. Where there is heavy machinery there'll crossings designed at a location to suit the landowner. It will be encased in concrete so if you want to take a 35 tonne machine over it you can do it at that point on your property. It's designed to spec, but generally it is at 750mm minimum cover. By the time you put your top soil back it's usually a metre.

For the cropping properties in the Surat we put it down 1.5m.

*The pipeline is generally buried with a 750mm depth of cover. However, in areas subject to deep ripping or other such practices, the pipeline is buried with a greater depth of cover, typically around 1200mm depth of cover. The design of the pipeline is such that a single*

*deep fork on the back of a dozer would damage the pipe coating or may even put a dent the pipe, but would not rupture the pipe. Our land liaison officers have been liaising with landholders to ascertain the relevant land practices. Existing landuse practices can be maintained over the pipeline following construction and rehabilitation.*

**26. Do you return the soil in the order it comes out of the ground?**

We're actually looking at ploughing it in, because when you do that you don't get that loss of stratification. Some of the pipeline trials we will be doing on the intensively farmed land around Dalby are ploughing in and removing the soil in layers and returning it the same way. However, ploughing it in seems to be one of the more achievable methods.

**27. We've been using a particular guy for legal advice for around 30 years but Arrow and QGC are now saying they won't pay his fees...and they won't pay the solicitor's fees either because they are too high. Where do landowners stand when the guy they've been using has had a legitimate business for 35 years (and I know he's not an accountant or solicitor or a barrister but he's helped us in the past) but now neither QGC nor Arrow recognise him as an expert. What are we supposed to do?**

We're not telling you that you can't use him. We have no problems with paying associated reasonable professional costs.

**28. He has a legitimate business, just doesn't have that bit of paper saying he is qualified. Why can't he qualify as being an expert when he's been doing it for so long?**

I can't answer the question about his qualifications, but the legislation specifies 'professional services', which is somebody who has qualifications in that field. Under the law what he is offering would be advisory services.

It's a fine line to draw; you are of course welcome to engage whoever you like. Perhaps your solicitor could engage him and we can pay your solicitor. But the basic thing is that under the legislation we are obligated to pay professional costs, and professional costs are qualified services and that is designed to protect you and your interests.

**29. In regards to the conversion of exploration wells to production wells, where do you draw the line between an exploration well versus in-seam and frac wells which are in the same area?**

Exploration wells are typically a 99mm core hole. To stop it caving in from the upper sections down to about 12m or so, we put in about an 8.5 inch conductor section. Then we put in up to a hundred metres of 6 5/8 intermediate casing and potentially 4.5 inch casing down to maybe two to three hundred metres and then it's all 99mm from there. Surface to in-seam (SIS) holes are drilled with a mud motor from the surface, generally with around a six inch casing for the production section and around an eight inch casing for the vertical. Frac wells are very similar with 8.5 inch casing and are cased the whole way through the hole. We plan that beforehand. What we want during exploration is continuity of the coal and to get those three crucial parameters that we are after: permeability, gas content and saturation. The second stage is to infill those areas with production pilots to prove that the gas will flow. Those are very well thought out as to where we put them. There is a vast difference between

the drill rigs that we use which are very similar rigs to the 99mm stuff for a lot of the SIS, but the frac rigs are quite large, getting on towards petroleum-style rigs.

Exploration wells have a finite life span of about a month while we are drilling them. At the end of that life they are cemented to the surface and due to their hole size they are not suitable for conversion to production wells.

### **30. So the current in-seam and frac wells can be used in future for production?**

Yes, if a frac pilot is successful we might not put all three on a pump; we might cement one or two up, or leave two suspended and bring one online. We install them quite tightly so that we can reduce the reservoir pressure in a minimal amount of time. If you just have one well in isolation it might take two to three years to get the reservoir pressure right to have the gas flowing so if we have three to five wells in quite a tight spacing in about six months we can start to get a reasonable idea of what the production profile of those wells would be like. Those wells might be quite closely spaced so then we may suspend the other wells and leave them as an option but we would only produce from one of them. If the pilot is a failure, and the area has been written off because of the low gas saturation or the inability to produce from it, then we would cement those wells up and rehabilitate the site.

### **31. What are you going to do with the water you produce? It will be quite salty won't it?**

Yes, it is quite salty in the Bowen basin. As a comparison, down in the Surat some of the water is quite sweet averaging around 2,000 parts per million (ppm) total dissolved solids, but in the Bowen it is generally higher. Our preferred methodology to deal with that is to use it beneficially. In our production fields we're no longer allowed to use evaporation dams because they just let salt build up. Instead we now use reverse osmosis (RO) plants which are quite costly but give us something we can use to better manage our water. We are currently trialling the use of CSG treated water to irrigate crops at our Theten property in the Surat. The RO plant actually makes the water too pure so the balance of calcium and other minerals in the water is not right; we then have to remineralise the water before it can be used for irrigation. What we would like to do is to substitute allocations. I don't think a lot of people have large allocations in the Bowen but we would look for farmers who might want to put it on their cropping or pasture land which would be a good outcome for us.

### **32. The water from here is saltier than seawater isn't it?**

No the water could be described as brackish and generally contains 2,000 - 10,000 ppm total dissolved solids compared to 37,000 for seawater. However the Bowen Basin produced water is normally more brackish than the Surat.

Nevertheless, our challenge in the Bowen is what to do with the brine that is produced from the RO plant. In the Surat we produce such volumes of water and brine that we could actually set up a salt recovery plant to create products like normal salt, soda ash and that sort of thing. In the Bowen the volumes of brine, which may sound quite massive, are not large on the industrial scale. So in the Surat we have a commercial option whereas in the Bowen it will be more challenging as we don't have the same scale. The water won't be a problem, it will just come down to the disposal of that brine. If we do build a salt recovery plant in the Surat it may be worthwhile to send it down there to be processed.

**33. There is probably more water here than you think. There are faults that run through this country that are extremely salty, they don't pump them for long but there are huge volumes of salty water in those.**

Generally we try to steer clear of those rather large faults.

**34. That'll be why you do seismic stuff, I thought maybe you wanted to drill into them to release the gas.**

The Rangal Coal Measures in particular are very badly folded and deformed so we needed seismic testing which is why you see a lot of it going on. The Rangal Coal Measures are a lot more challenging structurally.

**35. Why don't you go to the coal companies that have already drilled those areas because they know where the faults are?**

We do that so we usually swap data with our overlapping tenure holders. Typically we are working 'down dip' or deeper than they are. The other thing is that we need information to be as accurate as possible; in the Rangals there can be faults within a short distance of each other so we need to get that resolution with the seismic testing and we readily swap that information with the other companies. Quite often they haven't collected the gas data or they haven't collected it deeply enough.

**36. But would they be able to work out pretty well where the main faults are from their drilling?**

The intensity of faults in the Rangals is such that we actually need more than that to lay out these SIS wells.

**37. Because it doesn't just go straight down, it goes on an angle at times?**

It does. Some of the fault architecture is very complicated. With SIS drilling you don't need a fault of much more than a seam width to complicate the drilling of the well. You may have a five metre seam and a ten metre fault; in this case it's very hard to get back into the seam so a lot of your hole will be in stone, which isn't very good. Coal holds open better than the stone. We really need to know where the faults are otherwise we are wasting a lot of money drilling these wells.

**38. If a property has a bore and is using it fairly regularly what guarantee is there that you won't lose the capacity of the bore or won't contaminate it with this fracking? What is 'make good', what does that mean?**

'Make good' comes from the *Water Act* in Queensland. It simply means that if any capacity is lost in your bore, wherever that is, we are required to ensure you regain that capacity or have access to an alternative source of water. That requirement is clear and it remains even after we have completed our operations, for as long as we continue to have an effect.

What are the chances of us impacting? There are two different ways. One is by virtue of us reducing the pressure in the coal. As we take water and gas out of the coal the pressure goes down and if there are aquifers nearby connected to that somehow then the water levels in those aquifers may also go down in level. Here in this part of the world, around Dysart and

Moranbah, the chance of that happening is slim due to the fact that the coal measures are much deeper than the aquifers that most people have their bores in. There is typically about three to five hundred metres of rock between the coal measures and the source of landholder water. It's different in the Surat; sometimes their bores go beyond the coal measures so there is a chance of that happening.

### **39. Would they be artesian bores?**

Yes some are artesian bores. What we do is build a groundwater model to try to predict what those changes are. We try to understand what is between the coal measures and those aquifers to see whether they will be impacted or not. In some cases there is a chance that they will be impacted. In fact the Queensland Water Commission (QWC) has recently published its *Underground Water Impact Report for the Surat basin*. It has made a very similar assessment to Arrow in terms of which bores will be impacted. It's not a large number; out of 21,000 landholder bores in the entire Surat Basin I think the QWC predicts that around 500 will be impacted. It's not a large number but those people will still require appropriate compensation.

### **40. But the QWC could be wrong?**

It could be wrong; in fact our models are a bit more conservative or pessimistic than the QWC. The way to measure that and to make sure we know what we're doing is to monitor as we go and we do baseline assessments on all of those bores before we start. That's the way we can keep track of any potential impacts to see what is happening and how it changes over time and to improve those predictions.

The other thing that has been discussed is the fracing issue, suggesting that when you frac you could potentially affect the landholder's bore. As part of the regulations, even before the fracing takes place we are required to undertake a risk assessment to establish the risk of that happening. We undertake a baseline assessment of any bores within a given distance prior to starting the fracing operations. The chance of fracing going vertical is very slim, it tends to go horizontal. The whole purpose of fracing is to keep the coal open. What you do is you apply pressure which then tries to open those seams within the coal. Generally there will be around three to five hundred metres between the coal seam and your bore so the chance that the frac will open up vertically five hundred metres is incredibly small. We still do that risk assessment and check to make sure that is the case.

### **41. What's the average depth that you pull the gas out at?**

That depends on where you are in the basin. There is no average depth. We try to scale it out and 200m is about where it normally becomes economic. You can get a bit of gas at shallower levels but it is patchy and difficult to predict. The surface to in-seam (SIS) drilling has been profitable for us down to about 600m but between 500m and 800m is a bit of a crossover. That's where we've been trialling fracing because it gives you the ability within one vertical well to access multiple seams. SIS wells down to those depths won't be very profitable. We're trialling a different style of SIS where we drill down and get into the seam to do long reach; so we do a number of wells out of the same pad which reduces our hook-up costs to the wells and reduces our footprint i.e. we have four wells on one pad rather than having them spread out. Another option we are looking at is radial drilling which is on a coiled tube so there's no drill pipe to make up. That can go out into the seam for around

100m and is dragged through using a jet of water. It's just a matter of trying to unlock more gas. There's no average depth, but there does tend to be a sweet spot between two to four hundred metres due to the biogenic bugs that produce good gas at that level. We see the gas content increase at depths down to about 400m and then it starts to flatten out a bit.

**42. Does the temperature down there affect you much? I know when they are drilling for coal they check the temperatures and at around 800m it gets pretty hot.**

We call the amount of gas that can be absorbed onto the surface of the coal isotherms; the amount of gas that coal can actually absorb is temperature dependant. At three to four hundred metres we're looking at about 45 degrees and about six to eight hundred metres it gets up to around 55-60 degrees, so it's not too hot for us.

**43. Sometimes it gets up to around 90 degrees.**

We haven't struck too many of those areas. I imagine that's up around Coppabella?

**44. No, down here it sometimes gets up to that.**

We haven't seen that, but we do take temperatures for that reason.

**45. What sort of infrastructure is there when you put a wellhead in? Gravel road, power lines etc?**

Those things do go in as we need access to the wells for maintenance purposes. We are looking at methods to reduce maintenance but we do need to have roads into them, preferably gravel ones so that we can get to them in wet weather. Typically we have the ten by ten metre wellhead area fenced off, and then we like an area around that cleared to allow access. We've done risk assessments on fires and wellheads are fine based on bush fires. There's a lot of piping etc., it's all steel grade.

So what shows above ground? The wellhead comes up; it's a steel structure we can mount a pump on to allow us to pump the water out; it's not very big. We do need power to run the wellhead, we also need what we call a 'skid' which is a mechanism for turning the gas on and off and measuring the amount of gas that comes out of the well. All of that is held within that ten by ten metre area. There are options when we get to field development to use grid or mains power with power lines out to the wells. A lot of the farmers in the Surat intensively farm so they crop dust and don't want overhead power lines; we'll look at the potential of putting those power lines underground. There's also the option that we could generate the power nearby in a small gas fired power plant. So yes, Arrow does need a reasonable amount of infrastructure to go with these wells. Generally what it looks at is about a two to three percentage land use. If we had a full scale production with access roads and that sort of thing on your land, we'd probably cover about 3%, perhaps a shade over that depending on the pad layout. This is why we are looking at some of these pad drilling concepts where we drill four or five wells off the one pad. Half the cost is in actually hooking up the wells and the other half in actually drilling it.

From an observational perspective, if any of you want to come and have a look at a production field we are more than happy to take you out to have a look at it so you can see how it sits and how it impacts on land. If you are near Moranbah we have a production field there already and we are happy to take you out and show you how it works.

**46. The pipeline and all the spurs off it, is it going to be built all in one go or the main line first and then the spur lines?**

Generally I think it would be the main line first with maybe one or two spurs for the initial stations. They would be unlikely to build the lot in one go.

**Middlemount**

Date:	6 June 2012	
Venue:	Holy Family Church Hall, Howard Jones Drive, Middlemount	
Presenters:	Carey Bradford, Exploration Manager South	Arrow Energy
	Fergal Convery, Bowen Gas Project EIS Project Manager	Arrow Energy
	Melita Keast, Principal Community Relations	Arrow Energy
Facilitator:	Jan Taylor, Principal	JTA Australia

**1. Is anyone else trialling hydraulic fracturing in Australia?**

This process has been used for about 40 years in and around Roma. The other CSG proponents have to frac around 30% of their wells. In the Surat we don't need to because of the good permeability of the coal but in the Bowen we may need to because of tighter coals.

**2. How will you manage the waste from the salt you produce?**

Arrow will produce considerable volumes of salt in the Surat, but on its own the salt Arrow produces isn't enough for a commercial venture. We are talking with Origin and QGC about combining all our salt to make things like potash, table salt as well as other potential products. General Electric has been engaged to do the studies to find out whether it is feasible. In the Bowen Basin the salt content levels are generally a bit higher although the volumes of water produced will be much lower. We would have to look at some sort of disposal methodology as it probably wouldn't be feasible to set up a commercial enterprise based on the volumes and the distance we would have to cover; however, it's something we are still working on.

**3. The school-based traineeships, will they apply to Middlemount and Dysart as well as Moranbah? Or are they only based in Moranbah for the moment?**

They're currently based in Moranbah because that's where our present operation is but in terms of where we are with the Bowen Gas Project it's probably a bit too early to have those kind of programs here because we don't yet have a base for trainees to work at. That is definitely something we would be looking at in the future should the project go ahead.

**4. How far away from a water bore will Arrow drill?**

We will be several hundred metres away as a minimum. The new legislation around hydraulic fracturing means we need to assess those bores. Hydraulic fracturing is the main reason we would be concerned about distance from bores, particularly if the bore was into a coal seam. We don't have hard and fast rules at the moment. If your bore is into a coal seam as well then it would be at least a kilometre. If it's not in a coal seam, if it's in shallower sand, then it would depend on the thickness of rock between your bore and the coal seam itself, and that varies across the basin.

**5. Would one kilometre be far enough away from a bore if it's in a coal seam?**

Under the *Water Act* we are obliged to do assessments of water bores within a two kilometre radius before we do anything. We have to check the water levels and quality...and that's

regardless of whether they are in the coal seam or not. We then do a risk assessment based on how far those fractures might travel, which is not normally as far as a kilometre.

**6. How can you guarantee that? You may do a risk assessment but what happens if the water is gone?**

The methodology we use these days is micro-seismic. When we drill these wells in a pad we can actually measure through the vibrations where those fractures go. Generally we are seeing them about 100m around the well which opens up that permeability. The strength of the coal is about eight megapascals (MPa) and the rock is significantly more than that. Most of the rock is about 20MPa and the hard rock in the coal measures is about 60MPa.

The *Water Act* has a set of provisions that protect you from us in the sense that if there is any impact on the capacity or quality of your water bore we are required to make that good. In fact we produce a model to predict what we think might happen, and if we think there is a chance of impacting your bore we are required to put an agreement in place with you before anything happens, not after it happens. There are different ways we can 'make good'. Generally people want their water capacity replaced so we can do that in different ways or we could compensate you instead. With the agreement in place if it comes to pass there is an impact we can then make good according to that agreement.

**7. If someone had asked for water to be replaced how do you do that?**

There are different ways we can do it and the options will depend on where the landholder is. Typically we can deepen your bore or replace it depending on what the type of impact. In most situations we expect that it won't be a water quality problem but the level of water in your bore may drop. If that does happen we could deepen your well and place the pump lower. If that doesn't work there is an alternative to drill into a deeper aquifer if there is one present on your property.

**8. So around here where there is not much underground water and most people only have one decent bore, if you guys wreck it and you can't find any more underneath what will you do?**

We are still obliged to remedy the situation. The best we might be able to do in that situation is to provide a connection to a water service provider.

**9. So in 25 years when you run out of gas in these areas and leave no water under it what do we do then?**

We are still obliged to make good for as long as your allocation lasts, which is for as long as it takes.

**10. But for what length of time?**

For the length of time that it takes that water bore to come back to where it is now.

**11. But it might never come back?**

What happens with most aquifers is that they recharge over time. You can measure that recharge.

**12. Over what period of time?**

That depends on what sort of aquifer and what depth it is at. The shallow aquifers recharge very quickly and the very deep aquifers recharge very slowly. In the shallow aquifers, for instance the Condamine in the Surat, we saw that two years of flooding can increase the level by another metre and a half. The sorts of impacts we are predicting for the Bowen are less than in the Surat, the reason being that the bores are much shallower than the coal seams so for that pressure drop to happen as a result of what we do in the coal seams it propagates up only very slowly. We believe the recharge into your aquifers would be faster than the impact we'll have in this area. If it does happen however, we still have that obligation to make good; that obligation remains, it doesn't have a specific timeline and is guaranteed by law.

**13. I watched the *GasLands* documentary from the States about fracking; what happened over there is just scary.**

*GasLands* is about the shale gas industry and what we're talking about there is something far deeper i.e. two to three thousand feet. *GasLands* talks about rock, with two to five per cent organic matter in it. It is very hard, very deep and under a lot of pressure. It's quite hard to fracture that, and you probably saw some of the pictures there of guys with fifty-odd trucks parked all around and the mammoth amounts of water and sand they pump down those wells. When we typically do a fracturing job there would normally be three trucks, one with sand, one with a mixing unit, and one compressor. The depths and strengths of the rocks are very different. In terms of *GasLands* and shale gas and those types of things when you have something so deep you actually push it through windows of maturation. So when I was saying that coal can produce methane by being heated up, it produces methane that is 98% pure or better, with a little bit of carbon dioxide and maybe a little bit of nitrogen. When you take those small amounts of organic matter very deep and heat them up they actually go through the oil window. Produced from shale is a mixture of methane, higher hydrocarbons and condensates that are very volatile, oily substances much like petrol. That's where the two industries differ a lot because those volatile chemicals can have an effect whereas methane is not toxic unless it stopped you taking in air, and that would have to be in very high concentrations. While they are both unconventional industries, the difference between the two industries is vast. We are currently using gas drainage on nearly all our underground mines so most people who work in those mines are used to this sort of technology; in coal seam gas we just haven't seen the things they show in *GasLands*.

**14. In Texas people can light their taps with a cigarette lighter.**

I think it's been noted the particular taps doing that in *GasLands* have been known to do it since the 1700s.

Some of the fracking fluids used in the US may well use chemicals we don't use over here. Typically Arrow's fracking fluid is water, biocide and sand. The biocide we put down there is to kill any bacteria in the seams which might attack the casings. Every water bore in Australia is recommended to do something similar; you can use a chlorine compound but if we used a chlorine compound on the coal it might react with it which wouldn't be very good. We are committed to giving careful scrutiny to the fluids we use.

**15. When does fracking kick in up here? How deep?**

Generally our surface to in-seam (SIS) wells are quite productive. SIS is when we drill horizontally through the seam; down to about 4-500m works for us. Once we get through 500m plus it's not quite so effective. We're looking at how to access the gas further down which is why we are trialling hydraulic fracturing.

We deal with three coal measures. The top one is the Rangals, in between that in this part of the world is the Burngroves and in the northern part of the basin we call them the Fort Cooper coal measures. They are quite thick sequences, with coal up to 100m thick although with lots of clay bands through them. No one is actually mining them at the moment, although Aquila are talking about mining the Washpool deposit. They are quite high-ash seams but very thick so we're also trialling hydraulic fracturing through them because the surface to in-seam method doesn't work particularly well in those. It's a method of moving down deep, and also a method for looking at some of these odd coal seams.

**16. So are you only going to that Fort Cooper seam or are you going further down? In some places the Fort Cooper seam is only 75m down.**

We're trying to access all the seams. Generally it's not normal to see gas above 70m although at 70m it does start to pick up. Above 70m we don't really see it, or it's very patchy and very hard to tell where it is. Our normal target depths are around 2-300m. There are some places where we do see quite high gas content at shallow depths but that bucks the trend. Generally through the Bowen Basin the gas content and depth trend is quite predictable and plottable. There are a few areas that are different but we typically don't target above 200m.

**17. With coal seams do you need a pretty good thickness of seams like a coal mine does?**

In the Surat Basin (the Fort Cooper seam in the Bowen Basin is quite similar), we have what you might call a coal package rather than a coal seam. In the Surat Basin we would do vertical wells into that and we would complete them over the whole interval. In the Bowen Basin we have good thick discrete seams with large intervals between them and this is where surface to in-seam drilling works. We would drill multiple wells into those different seams. If faulting is much bigger than seam displacement, if you have a five metre seam and a five metre fault, it can be quite difficult to get back into the seam if you've only got a one point five degree bend at the front of the bit. It's much like a long-wall in that you can't just pick it up and move it down; you actually have to grade through it. When you drill through rock, the rock fills in easier than the coal; the coal also stays open a lot easier than the rock does.

The faulting gives us trouble. In the Rangals Coal Measures we generally do seismic testing before we do any work because of the level of faulting we see around them. A lot of that is taken up in the roof; there are a lot of shearing and reverse faults in the Rangals and it is difficult to pick good areas to work in without seismic testing. That's why out on the eastern margin of the basin we're looking to do more seismic testing.

**18. It wouldn't take much of a fault, maybe one degree; to pull you up a bit is that right?**

No. We can get back into it, but it is harder. Generally not all of our wells stay in the coal the whole time. If you are looking at around one kilometre well length there are normally some small faults in there anyway. If you end up striking a reasonably sized fault not too far away

from your production well it means that most of the rest of the well won't produce very effectively.

**So we're all hoping for faults now. I am anyway.**

#### **19. How deep will Arrow go to find gas?**

Some of our exploration wells go to about one kilometre deep. Sometimes we have a model that tells us what dip to expect and whether it's been faulted down. We've a lot of borehole data from the coal mines running north and south along the shallow edge; from that we predict that if we step out from that and something untoward happens (e.g. it drops down) we still want to see where the seams are so we can correlate them. Generally we aim for the 800m so that we can correlate the seams quite well but at the moment our economic limits would be around 600m.

#### **20. What percentage of your exploration holes would go on to be production areas?**

If I drill a well in the Surat Basin and I can see it has reasonable gas content in it then in the vast majority of instances I can say it's going to flow. In the Bowen on the other hand we've had some exploration wells which look fantastic but when we do the appraisal wells they haven't flowed. That could be due to the orientation of the cleat<sup>1</sup> direction in which we've drilled them or the stress regime i.e. it's very hard to drag the gas out of the ground because there is high stress in the area which tends to lock the coal up.

When you reduce some of the reservoir pressure to allow gas to flow, one of the other things you are doing is increasing the effective stress on the coal seam. When you have gas desorption going on in a coal seam for a while and you are flowing the gas the coal can shrink, and that can be the difference between having, or not having, reasonable permeability. In terms of the percentage of exploration holes which might go on to produce gas in the Bowen Basin, I'm going to guess it might only be 60% coverage both from the economic feasibility of being able to drill it and a cost-effective rate in terms of the return assuming all parameters are right. While our tenure area is quite large there will be areas either too deep or too faulted, that sort of thing. It is hard to say with the Bowen Basin though as some of the proposed underground coal mines are going to find it very difficult to get off the ground and get the gas out at that level. At over 7m<sup>3</sup> per tonne the coal will actually explode off the face of the mine wall, so that is why they need to do gas drainage to get it down below that level.

#### **21. How long will it take you to find out what the flow of gas will be?**

Typically six months to a year. CSG wells produce a lot of water early on. The permeability we talk about is absolute permeability of fluid which includes two phases; liquid and gas. There's an absolute permeability i.e. how much fluid you can force through the seam but there's also the relative permeability of gas through the seam as well as permeability of water. Initially, the seam is very permeable to water and we produce very high rates of water out of the wells; once gas desorption starts flowing that reverses so the seam is very permeable to gas but not to water. If you bring the well down quite slowly it actually forms a little bit like an embolism around the well causing a barrier to water flow; however, if you

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<sup>1</sup> Cleats are natural fractures in the coal.

bring your well down too quickly there is only a small area around that your vertical well will influence. If you bring the water down to the top of the seam quite slowly you produce from a far wider range around the well. Typically the gas flow goes up very quickly and then declines, carrying on at a lower level for quite a long time. The water is initially high and then drops to a constant at a much lower level. After six months we've normally seen the peak, but we may run it for a few more months just to get the profile that we're looking for, and from that we can extrapolate what the life of the well would be.

**Moranbah**

Date:	5 June 2012	
Venue:	Moranbah Community Centre	
Presenters:	Carey Bradford, Exploration Manager South	Arrow Energy
	Fergal Convery, Bowen Gas Project EIS Project Manager	Arrow Energy
	Melita Keast, Principal Community Relations	Arrow Energy
Facilitator:	Jan Taylor, Principal	JTA Australia

**1. At this stage does Arrow have an idea of likely workforce numbers in the area, both in the construction as well as operational phases?**

I can give you an idea operationally; by 2020 we'll be looking at around 500-600 people across the Bowen Basin and it would make sense to have three to four regional depots across the region. From about 2016 onwards construction-wise we are likely to have up to 1,400 plus or minus 30%. That's at the peak and it would reduce after three or four years. These are estimated numbers only.

**2. I was wondering if there is any idea of the approximate mix of the workforce in terms of permanent community members and fly in fly out. Will you try to move the majority of your workforce to the area or will there be a reasonable percentage of fly in fly out or camp-accommodated people?**

Our preference is definitely to have people located in the local community. Currently in Moranbah we offer a financial incentive to people to bring their families and live here. It's in the order of \$30,000 per year tax free on top of their salary so it's a big commitment. Currently in Moranbah we're looking at about 30% of our workforce living in the town. It's difficult with people like drillers and geologists to get them to move in and stay, we recognise that and we're trying to do everything we can to make it as attractive as possible for them to stay. It is definitely our preference to have a happier and more productive workforce coming to work five days a week. Fly in fly out can be pretty hard for families.

**3. Will the initial advice statement (IAS) for this project be released in conjunction with the draft terms of reference? Is it covered as part of the Surat Basin pipeline project? I'm wondering when it will appear? I've seen a tendency with DERM of late to release the IAS at the same time as the draft terms of reference which cuts it quite fine for an agency like ours when we are trying to assess the future resources we'll need.**

As I understand it at the moment the IAS Arrow submitted to the government approximately two months ago will be available at the same time as the draft terms of reference in early July. For those who don't know the IAS is basically a project description, it's an outline of what the project will look like.

**4. Our processes can't start until we receive official advice from the government agency that this has been notified and is forthcoming. Both agencies (the former department called DEEDI and what was DERM, which is now DEHP) usually release the IAS well ahead of the draft terms of reference. The latter is really just a template and we make submissions on those because there are very few areas that cover the points in which we are specifically interested.**

I can touch base tomorrow with the project manager from the department to request that he makes it available to agencies, or request that he contact you.

*Since this information session, Arrow Energy has made contact with the Queensland Police Service - Central Region to ensure official advice is received.*

**5. For the benefit of Emergency Services will Arrow flesh out the mitigation strategies for managing the impact of the future workforce and influx of industry on the community? You say you will be requesting feedback from stakeholders, was that in August?**

It will be July, basically just on the terms of reference. That is to make sure we have full coverage of what we are addressing in our environmental impact statement (EIS) which should be out for public review early next year. I think in your case the relevant item will be the social impact management plan.

**6. Yes. Will we be able to have further input at that stage?**

Absolutely.

**7. In relation to the small power stations that are going to be installed in some of those areas to power the compressors, is that compatible with what you are doing in the Surat Basin or will there be more of them here? If so, will that result in a higher level of contractor or Arrow specialist activity coming to these areas for maintenance?**

The idea of 'concept select' is that you start with all the options open and narrow them down as you reach your preferred and best options, based on the feedback from the community and the engineering work that keeps stepping up as we go. When we were at this stage in the Surat EIS we looked at about fourteen of these facilities which were optimised at nine by placing them in the Surat Basin so that the gas and water could run downhill as much as possible so we look at different options along those lines. In the Bowen where it says seventeen, I can tell you right up front there are two which won't stand up geologically. The EIS basically sets out the potential maximum impact so that we cover all bases. There will need to be maintenance and people coming and going from those facilities, but at this moment we don't know how many we will have and exactly where we will place them.

Geologically the Bowen Basin is quite different; some areas give up the gas quite easily while we may not be able to develop other areas economically. So looking at it, it will be rationalised but there will still need to be maintenance of every well throughout the Basin. We're also not yet at the point where a decision has been made as to whether we'll have a small power station or if we will feed off the electricity mains in the Surat Basin. We're still keeping that open because it's a big cost decision and in the Surat Basin particularly they don't want a lot of power lines because they aerial spray.

**8. In your presentation you talked about using the water from your gas wells for beneficial use. You are probably talking about some serious volumes over very long periods so I was wondering if you could elaborate on what some of those beneficial uses are and some of the infrastructure required to manage that water.**

Tight coals don't give up their gas as easily but the good thing is they don't give up as much water either. There's not as much space in the coal for water to be there. We're looking at

approximately one fifth the amount of water in the Bowen Basin to what we have in the Surat Basin. While it's still significant it's a lot easier to manage. In the Surat Basin we currently have our own farm, a place called Theten, near Dalby. We have a centre-pivot and we're putting our CSG water through a reverse osmosis (RO) plant. Believe it or not, when the water comes out of the RO plant it's too clean to go on the soil so we have to add things like calcium to balance the water chemistry. We're currently doing trials growing chickpeas and sorghum among other things.

Substitution of allocations is definitely our preference for beneficial use with the idea being we provide water to landholders instead of them taking the water from the ground. We think this would work particularly in the Surat Basin, in the Condamine Alluvium, and similar aquifers which are over-allocated at the moment. They can leave that water in the ground and use our water.

The other option is injection into aquifers to minimise the impact we would have. Another possibility is to provide water to mines or other industrial users.

**Blackwater**

Date:	7 June 2012	
Venue:	Blackwater Community Centre	
Presenters:	Carey Bradford, Exploration Manager South	Arrow Energy
	Fergal Convery, Bowen Gas Project EIS Project Manager	Arrow Energy
	Melita Keast, Principal Community Relations	Arrow Energy
Facilitator:	Jan Taylor, Principal	JTA Australia

- 1. Previously Fergal was talking about the key issues around the socio-economic impacts. We talked about affordable housing and I think there might be a need to include that economic aspect in there in terms of local supply because that's a key issue for the EIS in terms of how it integrates into, and benefits, the local community.**

That's a good point and we're happy to make sure that's included next time. Thanks for that.

- 2. One of the speakers earlier mentioned there'd be two gas pipelines?**

We have a Surat Basin gas production area and the Bowen Basin area. The Surat Basin will provide 60 to 70% of Arrow's gas and about 30 to 40 % will come out of the Bowen Basin. To facilitate that Arrow will have a pipeline that runs from up near Glenden, down past Rockhampton and into Gladstone and another one that runs from south of Dalby up near Wandoan and then through to Gladstone. So there will be two pipelines each of approximately five hundred kilometres, plus lateral lines, head lines, that sort of thing.

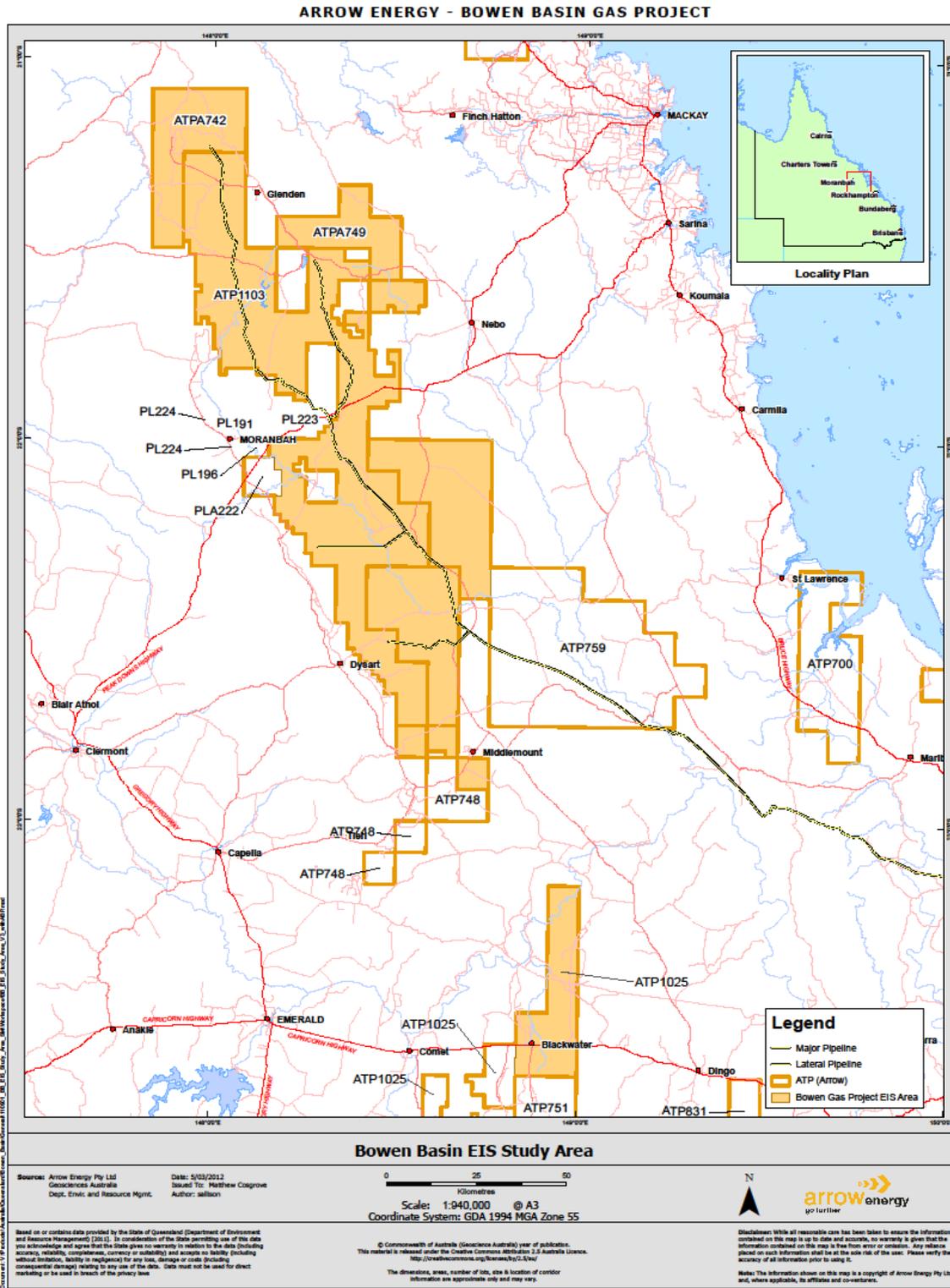
- 3. Does that pipeline come down through Blackwater to Gladstone?**

It's off to the side. A lateral pipeline will come up. You can see there that's the Arrow Bowen pipeline, heading to Gladstone, it comes up next to Dysart and into the tenure further up through the basin. Bow Energy was here [pointing to map] so it had its pipeline connecting both tenures and then heading east towards Gladstone, or to Rockhampton then to Gladstone. We will generally head north to south in some fashion, obviously not as the crow flies but taking all necessary considerations into account. The focus isn't necessarily on that exact design, that's just a general feeling at this stage. As I said earlier, the current timing of the development phase in the Blackwater area isn't in the imminent future.

*Please see next page for a copy of the slide shown as part of the presentation.*

- 4. What size is the pipeline?**

Pipelines such as this are laterals so they are really spurs off from the main pipeline. The main pipeline could be up to a metre in diameter, but that lateral pipeline would be typically 300-400mm.



Slide showing Bowen Gas Project EIS Study Area including the Arrow Bowen Pipeline Route.

**5. Will the Blackwater power station ever produce electricity?**

The Blackwater power station that Bow Energy installed?

**6. Yes, will it produce anything?**

Currently that power station is up for sale, not as it is in that location but as generation modules. It was never brought into production or commissioned and recently Arrow decided to sell it so for example some mining company may find a use for it to generate power.

**7. There's one well down near the showgrounds, and it is by far the closest well to town. Bow Energy gave a very strong indication that it would shut that well down, even though it's a producing well, because of its proximity to a recreational space. That's something we would like Arrow to do in the future.**

How close to residential areas is it?

**8. It's quite a long way from residential areas but there is some housing nearby. It's more the proximity to the showgrounds, which is the major recreation area.**

From an operational perspective, all of our exploration activities have been de-commissioned in this area. As a result of the Arrow takeover of Bow the priorities have changed because Arrow's focus is on the LNG project whereas Bow's was on providing gas to its power station. Arrow is in the process of de-commissioning all of those appraisal wells, and it will probably re-assess that after it has completed the final investment decision (FID) process which will be at the end of 2013. At that time Arrow will re-assess what it's going to do with the gas fields here in Blackwater.

If there is a concern about that well, if it is in close proximity to community activities, then certainly Arrow will honour any commitments Bow has already made to the community. Arrow will honour all the Bow commitments that have been made. Our land liaison officers have been down here and I believe have engaged everyone who has an existing contract or infrastructure on their property. We sent a letter to everybody in the tenement, whether or not they're impacted by the current activities, to let them know Arrow has purchased Bow and will be working forward with a program into the future. At the moment the Blackwater area is in decommission for the next eighteen months or so.

**9. It was a well that had good results coming out of it I believe, but it was significantly closer than any other well.**

We don't anticipate producing from that well, so it won't be much of a loss for us. Coal seam gas wells are quite sensitive to being shut in so it may never reach the production potential it had before being shut in. In commercial terms the value of that well is negligible to us; however, your concern means we should deal with it sooner rather than later.

**10. One of my questions is in relation to fly in fly out (FIFO) workers. My preference is to have a lot more of those people based within the towns. At the moment FIFO people aren't putting anything back into the communities. They're based in a camp, they live in a camp, they fly out and nothing gets put back into the community. Yes, you may have token bits put back into the community but the income generated by those**

**workers is not put back into the local community. Is there any way that more people can be based within towns?**

We try very hard; it's definitely our preference for people to live in town. In the past in Moranbah, we've offered a \$30,000 tax free inducement to live in town. Moranbah's very expensive so even with that inducement we were being outstripped by the price of rents. Recently we moved to cap our staff's rent at \$300, so even though some of the rents in Moranbah are in the order of two and a half thousand dollars for a house, we'll bring in a family and cap their rent at three hundred dollars. We're doing everything we can. There is a certain portion of our workforce, like drilling contractors and other technical or skilled people that generally can't be sourced locally. However, it is definitely our preference and it's definitely the way we want to work. People who work five days a week in the company are much more productive, they're on the ball, they know what the problems are week to week. When someone comes in for two weeks and then leaves, has two weeks off and comes back, we lose a lot of production time. It's definitely our preference but it is challenging.

**11. What is the end process with the brine? If you are continually producing that where is it put? What impact will it have on the environment later on down the track. There must be a huge lot of that produced.**

In the Surat where we produce more water and salt the volume of brine is quite substantial. , Australia does import soda ash but even though we will be producing large volumes we still won't have enough of our own to go into a commercial operation. Arrow, Origin and QGC are currently looking at pooling our salt or brine, and putting it through a commercial operation. The only real drama is that Arrow is in the pre-FID stage so it hasn't committed to spending the money and these commercial operators want the money now. Origin and QGC have contracted General Electric (GE) to look at what the options are and what would suit all three CSG companies in the Surat. It's not as cheap as re-injecting would be, but it's definitely our preference to do something beneficial with that brine.

The Bowen Basin is a more difficult case. The Bowen Basin is extremely tight so there are not a lot of briny aquifers in depths we could look at; it could potentially be possible but we're just not sure yet. The problem with the Bowen Basin is we cover so much area and the volumes are not as great. In the Bowen Basin we're still at the concept-select stage, so we start with all options open to us and as we get closer and closer we narrow those down based on economics and the social impact. So in the Surat Basin we'll probably accept a much higher cost option to be more socially acceptable but it's too early to say with the Bowen Basin right now.

Just to close that out, the backstop at the minute for brine management if there's no other solution is land filling it as a hazardous waste. So that would be done within a confined cell in a registered landfill.

**12. The Fitzroy is already exposed to high salt levels. When Ensham pumped out into the river here, you'd wash your windscreen and salt formed on it as it dried. And that was our town water supply, after Ensham was pumped out. My experience with the water is the heavy metals that are in the water being used. There are old pits out toward Bluff; there's no algae in those old pits because of the heavy metals; nothing**

**survived; there's no crayfish or anything. We've already got a high salt level in the region and it's all feeding into the Fitzroy, so it's a major concern for a lot of people.**

That's right. I was living in Tieri so I know what it's like. We will look at all the options and then consider what to do. It's difficult for us to obtain environmental approvals for the soil encapsulation style. It's not acceptable to just 'dig a hole and throw it in'. Any landfill we took it to would have to be licensed for hazardous waste, not just any old landfill.

- 13. I suggested to Bow when it was spending a considerable amount of money carting water away from home that it was throwing money at the problem. You say our water's only a small amount compared to down south but my suggestion to Bow was why not concentrate the brine and cart the hazardous part away, let the water go where it is, I'd use it if it was clean.**

**Now that Arrow's taken over, take that hazardous salt or brine down to the Surat, put it in with what you're producing down there, and that can be part of a viable commercial product, but done in a way that you can cart it a distance. The money that they were spending on carting that water away was really just burning up diesel and that wasn't very environmentally friendly. The diesel Bow used getting that little bit of water was probably doing more damage than a coal power station wouldn't you say?**

I take that on board. In the past CSG companies have put the water in a dam and let it evaporate; we're not allowed to do that anymore. The preferred method is to use a reverse osmosis (RO) plant, which concentrates the brine; that can be held and either crystallised or something else done with it before it's taken to a hazardous waste facility. Believe it or not but the water coming out of the RO plant is too pure to be used for irrigation, although we can amend it so the sodium absorption ratio is correct. We would add some calcium to it and let a bit of nitrogen and carbon dioxide percolate into it. Then we can look at beneficial use agreements, whether that's giving it to the town or to someone who does water cartage locally. It is a very difficult process with government at the moment to negotiate how to put those beneficial use agreements in place. Hopefully with a bit of sanity these things will happen a bit quicker in the future. We're in a very difficult position; we produce the water, it's called waste but we don't actually own it even though we have responsibility for getting rid of it. We can't sell it, even when we treat it. Maybe the rag-tag set of legislation we currently work under can be amended to enable us to work more efficiently in the future. I think realisation is coming that the scale of the CSG industry warrants consideration of how we can work together.

- 14. Where's the technology at with RO? Are there mobile plants you can bring in? Our fields are scattered and I know you're only at the development stage so you really don't know what's going to come. However, Bow was talking about digging turkey nests and putting the water in there. I cooperated to the nth degree to try to get something safe built, but we never got to that stage. It seems to me if you can bring RO plants from hole to hole and operate them then they wouldn't need to be there fulltime; they might be there for a few days of treating the water that's there and then move on. Where is the technology at? Are the plants mobile at the moment?**

They can be. We've had plenty of presentations from the oil field producers. The plants come in semi-trailer sized compartment and we're looking at a similar style of thing in the

Surat because down there we've got 400 megalitre dams that will fill up in a short time. So yes, those things are available, they're not cheap so the cost of doing RO is quite expensive but it's our responsibility to do it. At full scale production those facilities that Fergal was talking about can be used to treat the water but as a stop gap we are looking at those more mobile facilities not just for water itself but for drilling fluids. Currently we are trialling pitless drilling in the Surat so there are no holes; we use tanks that sit on top, then we put the cuttings through a centrifuge. It comes out like toothpaste into a box and we recycle those drilling fluids. You just have to add the water that was going to the waste stream. We're looking at engineering solutions to reduce the waste and produce better products. We are currently using potassium sulphate rather than potassium chloride to weight our fluid and we are actually looking at beneficial uses for those drill cuttings with the potassium in them. The only things we really add to our drill fluids at the moment are cellulose, guar gums and potassium sulphate which is quite a good fertiliser. A lot of people have said they would take it. Once again we're constrained by having to prove that it's not a regulated waste. Anything that comes out of the ground as regulated waste has to go to the dump. We're working closely with the government at the moment to change that so we don't have to drag it all over the countryside, ruining roads and burning diesel.

**15. So when we let you into our paddock, you realise that you're entering our production area?**

Yes.

**16. And our production's regulated just like your production, but by food safety. My biggest argument with everybody that's come from Bow as well as you Arrow guys will be the same. We know that you blokes will be in charge and you'll know that a lot of your blokes at the well or drill site don't realise that when they walk around the paddock leaving things we may not be in business if we can't continue to produce safe food. Those chemical products you get out of the ground, I've previously told Arrow people, and Bow before that, they have to be removed. There's no material data sheet, nobody can really prove what's in a sump, a drilling sump's like a sewer when you drill the hole. We've got to be very careful when you're occupying an area that's ten metres by ten or seventy metres by seventy, is it actually safe.**

**So my biggest worry is anyone in my paddock who I don't actually control, what is in the stuff they have in their possession that could be left there.**

This is why we're going to pitless drilling on cotton farms because we can actually test what's in our container - like the drill cuttings. We do have material safety data sheets for all the stuff that goes in the hole and most of it is actually food grade because the coal is pretty fragile and we don't want to damage or block it up while we're trying to test it. What we can do then is test what's in the pallet, send it away to our lab. There are some places in the Bowen Basin where the soil levels have a naturally high level of arsenic; it's natural but we test it anyway. I do understand your concerns here. Currently we are looking at a three layer polypropylene matting that we can spread out over the whole workplace. So we are looking at a complete minimum ecological impact solution.

We're happy to provide you with material safety data sheets (MSDS) for rig specifics. However, we don't have anything to hide so we could give you a copy of the MSDS for what is used in each rig (because it may vary from rig to rig) on your property.

- 17. When you talk about the brine, nobody seems to consider the fact that there might be something worth selling out of that brine. You might have gold or something else in amongst your samples; if you can find something useful surely you could solve the issue. We've waded into some of the ponds trying to get things out of them; we got rashes and some burns but there could be something valuable in there.**

It's pretty hard to extract it...

- 18. But you've got to clean it up anyway?**

Yes.

- 19. So whatever you get out of it, you know you could use that as a mining technique in the water. The typical case is Mt Morgan mine; they tell me there's sulphuric acid, but for the life of me I can't work out why it can't be used because all you have to do is drop lime straight into sulphuric acid and you'd be producing a gas you can use for generating electricity. Why hasn't somebody done it? You've got a pit there, it's like battery acid running back through the dam and the irrigators get all their crops burnt if they irrigate the wrong time of the day. Surely it's not that hard, if there's gold in the pit, there'd have to be some in the water; you produce gas out of it and you can generate electricity.**

Yes.

- 20. That's the problem with the mining industry at the moment, all it wants is coal. If I say to the miners that copper usually goes with gold, why don't they remove it and take it to the smelter for processing I'm told 'oh no, we're not allowed to touch that'. It's stupidity, everything that comes out of that hole should be used in some way or form - stones, sand, whatever. That's the whole thing with the mining department, it's got to change its way of doing things. Miners should be able to utilise everything.**

Generally the produced water takes large amounts of chloride. There is generally not too much of anything else; we mentioned heavy metals, but there are very low levels of those and they've been looked at in the brine re-use programs. However, I will take your comments on board.

- 21. I just wanted to make a comment on the gentleman behind me who made the comment about FIFO workers. I think 95% of the problem is the lack of available land, not only in Moranbah, but Blackwater, Wandoan, Clermont and Alpha. For instance, Wandoan is reputed to grow from 500 people to over 7,000 but there's no land available now. That's what's causing these rents to be up to \$3,000 a week. If there are any council officials here tonight they should be concentrating on that; doing something about making the land available so people can buy it and develop it. Then they might be able to keep some of those workers in town.**

**We're a local service and maintenance business which is not directly related to gas production but I would still see benefits from Arrow's development contractors and**

**then drilling, earth moving etc. Is there some sort of database that local business can be a part of so those contractors can contact us? There are tons of little businesses like us. Yes you can always get them from Brisbane, Sydney, Melbourne but in regards to the FIFO issue a small part of it, can be fixed by using local business. I understand that big companies generally want to support local businesses but if there's a database how do we get on it?**

If you jump on the Arrow website there is a Supplier section where you can register your interest in future opportunities.

[[http://www.arrowenergy.com.au/page/Careers/Suppliers/Register\\_Your\\_Interest/](http://www.arrowenergy.com.au/page/Careers/Suppliers/Register_Your_Interest/)]

Arrow also has a local content policy which is available on the website too.

**22. I've just got a small question, after you get the water out and clean it who owns it?**

It's basically waste so no-one owns it. Our obligation is to get rid of it.

**23. The guy who's drilling it on the top of the ground, does he own it?**

No.

**24. That's strange isn't it?**

It is strange. We can enter into agreements with landowners for beneficial use arrangements where they take the water. We are looking for these partnerships to get rid of the water because we don't own it. At the moment we are talking to people like water carters, irrigators, feed lots, those sorts of things, so yes it is difficult.

**25. Somehow it ought to be legalised because if you start irrigating a paddock and someone comes to you and says that's not your water what are you going to do?**

I think landowners have rights to use the water but they don't own it. You own that ground, you just don't own a lot of the things that are in it but you do have rights to use it. What's below the ground is owned by the state and federal governments. I guess the rights to the minerals and water is for the benefit of all, so that's why governments keep those rights, even though you own the dirt that it's in.

**26. In the United States, there are petroleum bores and the fellow that owns the land sometimes gets the benefit from it. For example they can use the petroleum fuel in their motors or whatever, is that a possibility in your industry? If you're going to shut those wells down for the next ten or fifteen years, why can't you generate power and put that back into the power line we've got there. You could sell your gas, even though it might only be a small amount but it would be more beneficial for the landholder. We can't get three phase power and it's just a pain to us. You see all the three phase equipment around the world which we'd love to use, and we can't get three phase power. The only option we have is to somehow generate it ourselves so that's my other option. We've driven past these bores for the last couple of years and there are motors running there twenty-four hours a day, for twelve months of the year, and all they're doing is just pumping water out of the ground. I thought to myself, I don't know how good the wells work, but you know instead of capping them is there any way you can generate something to sell?**

It depends on the tenure conditions. Under the Authorities to Prospect (ATPs), once we've done our appraisal wells once again we can't sell you that gas, we couldn't even give it to you if we wanted to.

- 27. That's where the system stinks doesn't it. We had Ken O'Dowd come to a meeting the other day and I said to him the companies dig a hole for a coal mine and there are metres and metres of good sand and brickies' loam which is fairly expensive when you get to the big city. Yet they do nothing with it and you're in the same situation with the gas, you can't help anybody with it. You don't own it but you have to get rid of it.**

We have asked farmers in this area if it would be a benefit if we could provide you with the gas line. That's one of a few things we are looking at.

- 28. If you've a bore that's not good enough for your production, but it's good enough to help somebody out, that's only a small amount in the big picture, but it might be useful to somebody eh?**

Yes, I agree with you. It is a tough legislative environment.

- 29. We just reckon it's a great shame too, the power station you've got out there, you can't sell it off; just seems like putting the cart before the horse.**

The model there which a lot of small CSG companies have followed, and Arrow did start that way too, is that you put in a 30 megawatt power station to prove your concept. If you can do that then your gas is seen as valuable and as a company you are worth being bought out. Generally those facilities don't make much money. The main use is on a coal mine where you are producing that amount of gas and you want to actually use it beneficially. The power station at Oakey Creek never used to make much money for us and without government incentives it would have been hard to justify spending the money to purchase it. Where you can make money on gas though is at the 400 megawatt power stations and they are the sort of things we would be looking at for domestic style of products. Those smaller ones are not particularly efficient and really don't make that much money, so they are something you wouldn't want to get into unless you are trying to prove your value to the big players.

- 30. If you look on the other side of it, you pay us basically useless money for the fact that you've got roads and all those different things. Now if we supplied the motors and generators and you supply the gas and gave us the use of the motor or something like that, that could be useful to you and to us. As it is, it's just a hole in the ground with a fence around it. There are a lot of people who could use that.**

I agree.

- 31. In fracturing your coal seams, what chemicals are used? Are they detrimental to using that water? How does the fracturing affect our water tables as in stock bores or artesian water? In this area we do have artesian but it's further to the south.**

Hydraulic fracturing is where the coal is very tight and we want to fracture it open. We pour sand down into so that once it is open it doesn't close up again. That opens up an area of roughly 100 metres around the well for the flow of gas. It's had a very bad reputation

overseas where what they do is very different to what is done in Australia. Even Texas refers to the Queensland Regulations and it is starting to adopt what we have here in Queensland as its regulation for hydraulic fracturing.

Coal generally has a strength of about eight megapascals (MPa). The rocks around it can sometimes be weak and give you problems when you're mining it e.g. a weak roof and floor that's generally fairly narrow around the coal seams. When we get any appreciable distance away from the coal seam, generally we look at about 20, 40 even up to 60 MPa rocks around them so we can see the coal is quite a different strength from the rocks around them.

We believe the fractures that we push out into the coal seam remain in the coal seam. Currently when we start working in a new area, when we do a frac pilot, we have five wells to study that effect and ensure we can produce evidence that the fracturing is staying within the coal seam. We do something called micro-seismic; we put seismic detectors down nearby wells, we read what the seismic shows and we can tell how far they propagate out into the coal seam.

Arrow runs what it calls a slick or hydro frac. It's a method of hydraulic fracturing where Arrow typically uses 99.9% water, a tiny bit of acetic acid or vinegar to adjust the pH<sup>2</sup> in the water, and a biocide. Generally in every water well that's drilled you would use something similar to disinfect the well. In a water well you would quite often use chlorine for this purpose but it's not good for us to use because it can form quite toxic chemicals in reacting with the coal. The biocides that we use are designed to kill bacteria which potentially could eat the pumps or casing or just clog the well up. They are short-lived, do their job and are just like a disinfectant that you would use on your table top at home. We use very few chemicals. The Queensland fracking legislation now requires us to provide the landowner with information about exactly what and how we pumped, how many stages, and what pressures we used.

Hydraulic fracturing overseas is usually for shale gas. Shale gas resides two kilometres or so beneath the surface; its rock is made up of only six percent organic matter and is very strong and hard. The shale gas companies probably have 50 compressors to break that rock apart so you'll have 50 trucks lined up, massive amounts of sand, massive amounts of water. What we use in the CSG industry is generally one compression truck, one sand truck and one mixing truck. It's a much gentler process because coal is weaker. The other difference with shale gas is that it's so deep and has to be pressured up so much. What is removed with shale gas is predominantly methane but you do get higher hydrocarbons, a lot of what we call condensates i.e. volatile hydrocarbons. This is where people could become sick from coming in contact with them.

What we have in CSG is a very pure methane gas. My lab reports show 98% methane, a little bit of carbon dioxide and a little bit of nitrogen, so a very different set of substances. With CSG, if our coal seam was 100% saturated we would drill into it and wouldn't need to remove any water out of it, it would flow straight to the surface there and then. If the coal is a little bit under-saturated because the Basin has settled in recent times, then we need to remove a bit of water to reduce the reservoir pressure so the gas will flow. By doing that, we reduce the reservoir pressure so there is an effect where the rocks around the coal seam are

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<sup>2</sup> A measure of acidity or alkalinity.

a bit leaky. Where the coal swamp forms is the most quiet sedimentary environment you will have, 10 to 50 metres of leaf matter built up with very little dust or rock or anything getting into the coal seam so it's very quiet. Next you will see silt stones, a more energetic environment, coming on top; then sandstones and then quite often it will go back into a silt stone, and then into coal, silt stone, sandstone, so it's a change of sedimentary environment in the swamp that sets up these layers. Because the silt stone layers are so tight, we refer to them as aquitards.

Anyone who has been in a coal mine will know that it's leaky. While those rocks are fairly impermeable they do let water through. If we reduce the water pressure in the coal measures, if there are aquifers above and below the coal measures in multiple sequences, you would find the ones closest to the coal seam will leak into the coal seam with the greatest effect. That would be lessened with each additional set of your aquifer resulting in a buffering effect. By the time this reaches the surface aquifers the effect is of a far lesser magnitude than the draw down experienced by the coal measures and adjacent aquifers. In the Surat Basin where we produce five times more water, the effect on the surface aquifer would be less than 50cm in most cases. In some of the closer aquifers it would be a couple of metres. So the effect of all the CSG proponents, with four major gas projects on the go and probably 25,000 wells in production, will produce a fairly negligible effect on those aquifers. There will be some areas where people are affected for various reasons e.g. the Walloons or the Condamine Alluvium where they source their water or for other reasons. Before we go into any production fields we need to do baseline assessments on the quantity and quality of water. If we do impact those bores, we need to make good. A make good arrangement could mean we dig your bore deeper; perhaps we take the pump out and put it deeper in the hole or it could be that we have to produce water and pipe it to you from one of our facilities. That make good provision is there for as long as the effect is there. This is one of the benefits of working with multi-national companies like Shell and PetroChina; we have massive financial backing.

### **32. What impact does the activity have on aquifers and the environment as it used to be?**

The top aquifer, which is what most of your land is reliant upon, is only negligibly impacted. We do see a drop in a water column, it can be 50cm in some cases and in some a metre is taken away. In the last two years in the Condamine the top aquifers have actually come back by a metre and a half with a flood event. Those aquifers are heavily used for irrigation and crop farming and were probably a bit over-allocated at times. They were dropping measurably because of land use in the area but with flood events for a couple of years they've started to replenish, so it was a relatively short-term effect. For some of the deeper aquifers it can be a reasonably longer term effect but if that happens because of our CSG project we will make good so there shouldn't be a major effect at the surface.

### **33. Do you ever see subsidence in the ground anywhere around your wells?**

No. The gas obviously comes from somewhere and we do see minor shrinkage of about one to two percent of the coal volume. We know the mechanics of removing coal from the coal mining industry so we can model subsidence. They've been producing CSG in the Powder River Basin for forty years and there's no subsidence that has been recorded.

- 34. I have some friends at Rolleston with a massive well. It's been there for about 40 years but over the last fifteen years it's gone down to about 20% of what it used to produce. On this particular farmer's cultivation he's had a couple of instances where he's had a hole the size of this room just drop down eight feet and nobody can really explain it. I was wondering whether you've ever seen this sort of thing?**

The only time I've seen anything similar is when the guys do what we call the first set of casing, the conductor casing, which is to hold back any loose sands. If the drillers don't put it in deeply enough, the circulating fluid washes the sand away from under the rig and there can be quite a large hole there.

- 35. Well this isn't anywhere near the well. He was driving along one night and all of a sudden he was just about in it. He had worked the country three months before and now there's one big patch like that. He's filled it back in again but I thought it might be something you can explain.**

No, that's not something I have seen before. Generally we start extracting gas at about 200 metres. In the Bowen Basin it's probably a little bit deeper to do the surface to in-seam drilling so there's quite a distance of competent rock between us. If there is the potential for alluvial material in the upper sections of the well we try to case it out with the conductor and surface casing.

- 36. That well I talked about is the one that connects from Rolleston there and goes out to Injune, it's the same well. To this day nobody can really explain it and I wondered if you had seen anything like it?**

No, we haven't seen it with our wells.

- 37. In regards to the land liaison officers is there any way you can prove that they have done the right training or that they know what they should do on our property?**

We have land access rules which are above and beyond the rules in the government's Land Access Code so we have a certain level of internal compliance requirement as well as the government legislation. All our staff undertake a land access induction course as part of overall induction, and there is a specific land access induction course that people must do before they are permitted to represent Arrow on site. That includes not only employees but also contractors and drilling companies. We do have verification, everyone on site should have a card that says they've completed a land access induction course and it's valid for twelve months so they must redo it every year.

Most people in this area are new to Arrow because it's taken over a Bow Energy tenement. About two years ago, we looked at what was happening, how it was working with landowners. There was some misunderstanding, confusion or mixed messages because every man and his dog was out in the field talking to landowners - and everyone had a different message. They were probably saying the same thing, only in a different way, but people were getting confused or getting different stories from different people.

What we've done at Arrow now is ensure that individual landholders have a dedicated land liaison officer who is your one point of contact for all activity on your property.

We have standard rules about leaving gates as you find them; unfortunately it doesn't always happen and sometimes you might have one of the contractors leave a gate open and your cattle are mixed up. We all know the consequences of putting the wrong breeders with the wrong bulls etc. There's also a cost involved for you to re-muster or redraft your cattle and put them back where they belong so Arrow has a liability if that does happen and it's proved to be its fault; Arrow accepts that responsibility.

The other issue is in weed and seed management where there are wash down requirements and things like that. We will do individual access conditions for each property which is complied with and that will be logged into our work operations processes. If you've a question you want answered, you just ring the land team which will source its knowledge from the EIS guys, the geology guys, production, corporate or wherever the answer needs to come from. We will commit to take your questions on board and get back to you with a response. The land team is a single point of contact for property and landholder specifics; the community team is for general matters.

**38. In regard to weed management, if you have to come to my place and you've come from somebody else's place, you've got to go back to town and wash the vehicle. You know the logistics, it costs a lot of time and money. Has anybody come up with a system, for instance mounted on a semi-trailer, to do the wash down?**

We do have portable wash down units.

**39. But in a semi-trailer form where you just go onto a property and it washes itself automatically...**

There is a whole range of different possibilities out there. Weed and seed management and wash downs are probably the most challenging things at the moment. You're right, if your property is next to someone's with weeds on it and you haven't got that issue, then we've got a massive problem if you're four hours out of town because we've got to come back to town for a wash down, especially our rigs. That could be two days' worth of lost time. But yes, we've got to do that and yes we are looking at ways to resolve the lost time and the complexities of that. We do have some portable wash down units but they are mainly for light vehicles, not so much for heavy vehicles. But we do manage it very tightly. A lot of people are happy with just the wash down or a blow down, other people want certification. All of our land team and some of our exploration appraisal guys out in the field have done weed and seed training; they have qualifications in how to wash down, what to look for, and they have certification. We have a policy where we don't allow people to self-certify. I can't do my own car, but one of my guys can do my car or one of the guys from another team, we can go and do their cars, to ensure that we don't become complacent. Believe me, our guys are pretty rigid on it and if there's something that is inappropriate, they get sent back to rewash them, so we are pretty strict. I won't say we are going to be perfectly clean because that would be impossible to say, nobody can guarantee that, but we do whatever we can to ensure the vehicles are clean.

**40. Something simple like if you had an outlet for your water that you could use?**

There have been situations where people have requested that we do a mist spray of diesel over vehicles because that stops the germination of the seed. Apparently there is something DPI has brought to light this year that is a similar thing that resists, slows down or kills the

germination of seeds, so yes we will be looking into that. What Arrow has done, only in the last three months, is employ a weed and pest management expert to work for us to develop our policies and processes to ensure that whatever we do, we minimise our potential to cause issues with weeds. On the back of that again, we have an obligation, legally and morally, to manage those weeds. Like our make good with the water, we've got an obligation to manage any weeds that it can be determined we brought onto the property. They may have been there forever, or they may have been there for 15 years, but the fact that Arrow has run a truck through your property and has stimulated their germination so they've grown, yes we'll manage that in a range of different ways.

**41. What size coal seam are you aiming for and later on with improved technology can it be mined as a coal?**

Generally two and a-half metres is what we aim for as a minimum width for surface to in-seam drilling but it does depend on the gas content and quality of the coal. When we work in the Surat Basin, we have about 25 metres of coal in the gross package. We tend to see a metre of coal, a metre of rock, a metre of coal, so they act more like packages. We can complete all of those in one well so individual seam thickness is not as important. Within the Walloons there are two sections, the Juandahs and the Tarooms, and they both have quite large packages in them and a bit of a break so we might just do a Juandah well and a Taroom well on the same pad to take advantage of the coal that we see.

In fact in the vast majority of cases at least some of the gas needs to be removed to safely mine the coal. If the gas content is too high the gas escapes from the coal so quickly that the coal explodes off the face of the workings and this can be several hundred thousand tonnes. The amount of gas that needs to be removed is specific to the modulus of coal i.e. how strong it is. We call it the outburst potential or threshold of the coal, which varies. In New South Wales it's a little bit higher, in Queensland a bit lower. In Queensland if you have more than about 7m<sup>3</sup> per tonne of coal (which isn't very high for the Bowen Basin) when you try to mine it the gas will escape off the coal so fast that it will outburst.

It led to different things in New South Wales e.g. the armoured miner, where they put miners into completely armoured mining equipment. All that happened was that the miner got buried for a couple of days. The reasons why outbursts occurred was not very well understood and a lot of science went into understanding coal and what we can do to prevent those kinds of incidents. Leichhardt and Cook Colliery here near Blackwater were some of the worst mines for gas because the gas contents are extremely high. But it's also very tight so it doesn't want to give it up very easily. The guys used to go down with scroll drills and blast the face away to try to combat the outburst. In the intervening years of study and science, we've worked out that if we actually drain the gas out of the coal ahead of the mining we can make it safe. There have been no major outbursts in Queensland coal mines in recent times since we started using this style of pre-drilling and draining the gas from the coal. Quite often it can be underground fan drilling where they send a gas riser to the surface. You can only do that just ahead of mining so it's done when you are driving your gate roads.

It impacts on project schedules if you can't get your wells in on time but with surface to in-seam we can put those down many years ahead of production. So yes you can mine it, and it's quite possible. In fact you have to do it in those places. Newlands got away with only gas draining part of the mine. I think Eagle Downs won't be too bad, but nearly every other

underground mine in the Bowen Basin has to undertake some form of gas drainage. The US has the same sort of problem and there the chosen method of removing the gas is hydraulic fracturing which has been used in the States for many years without any problems.

**42. A lot of people here have some understanding now because of the number of projects throughout the area but in July you've got the draft terms of reference (ToR) coming out; can you briefly give people an understanding of the purpose of that?**

The ToR is like a recipe for the environmental impact statement (EIS). The ToR is about 40 or 50 pages that are initially worked through with the government and then released for public review. In brief it states what the issues are and nominates some of the things that need to be considered in the EIS. But if people think something has been missed out, they can make a submission which doesn't have to be in fancy or scientific words but make the desired point.

**43. This document, the ToR, some of it is written in essay style which is difficult to work through but a lot of it is more dot point form and under separate headings so if you are concerned about accommodation, you can go to the social impacts on accommodation; if you are concerned about water quality, you can go to that area. You can actually see what's required in the EIS, you can see what questions are being asked. If you think the parameters or boundaries of those questions are not clear enough or there's a really important question that's not being asked, you can make a submission saying 'I think you've missed xyz and you should put it in'. The state government will look at your submission and see if the EIS needs to take that into account.**

It can be one page, one paragraph.

**44. In relation to that, will they be available on your website?**

Yes, and towards the end of this month there will be newspaper advertisements in all the local and national papers.

If you have those sort of questions in a few weeks' time there's a freecall number and an email address (1800 038 856; [bowengas@arrowenergy.com.au](mailto:bowengas@arrowenergy.com.au))

**45. We use the Blackwater Library here as a location where you can pick up a hard copy of the terms of reference and have a look at it. The terms of reference include something called the impact assessment statement which gives you all the background for the project. You need to look at the EIS and then look at the terms of reference so you get all the information together.**

I think you mean the initial advice statement which is like a brief project description to help the terms of reference make sense.

**46. How does your gas vary from diesel when it's actually burnt? I wondered if it's any cleaner.**

It's actually a lot cleaner.

**47. Is it a full burn, what goes in?**

Methane (CH<sub>4</sub>) plus oxygen comes out as carbon dioxide and water. The only other thing you will get is some nitric oxide compounds because there is so much nitrogen in the air. It's a very clean burn and the level of particulates is almost nil. There is no sulphur at all, so it's extremely clean. It's one of the cleanest burns you will find bar hydrogen.

**48. I used to work in Curragh mine for a while and if I looked over the side of a pit on a really hot day it would burn your eyes with the methane, the gas from the coal. You'd smell it and it would burn your eyes.**

It wouldn't have been methane because methane is colourless and odourless.

**49. What could it have been then?**

With the environment in open-cut coal pits, there might be pyrite and other minerals so pyrite (iron sulphide) which is breaking down. This is where CSG water is very different from the water that you will find in a coal mine pit. All the rocks are breaking down and oxidising. If you take pyrite and break it down, it will form sulphuric acid which then causes other rocks and minerals to break down.

**50. You used to only get it on a really hot day; even in the bottom of the pit it would burn your eyes all the time.**

Heat helps to drive those reactions; you commonly see them in volcanic areas.