Katherine – Origin Energy

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Katherine Godinymayin Yijard Rivers Arts & Culture Centre, Katherine

Speakers: Dr David Close, Stephanie Stonier, Alexander Cote

Hon. Justice Rachel Pepper: Yes, if you could please state your name and if you're appearing on behalf of an organisation, which organisation? Thank you.

Dr David Close: Dr David Close, from Origin Energy.

Hon. Justice Rachel Pepper: Thank you.

Stephanie Stonier: Stephanie Stonier, Origin Energy.

Hon. Justice Rachel Pepper: Thank you.

Alexander Cote: Alexander Cote, Origin Energy.

Hon. Justice Rachel Pepper: You might need to speak closer to the microphone.

Alexander Cote: Alexander Cote, Origin Energy.

Hon. Justice Rachel Pepper: Thank you very much. Yes, when you're ready.

Good afternoon madam chair and distinguished panel. Firstly, on behalf of Origin, I would like to acknowledge traditional owners of the land we meet on today, and the elders past, present and future, and we also acknowledge pastoral owners and pastoralists who have been hosting us and working with us in our permanent area over the last three to four years. We appreciate the opportunity to present to the panel today and respond to the interim report which we recognise as a really important piece of work in the inquiry process, and also respond, at least in part, to the panel's recent request for information.

We also plan to submit our data and written response to that recent request for information. We support the inquiry process and it's important to bring certainty to the entire gas industry. It's an industry that we believe could bring socioeconomic benefits to the local communities in the Beetaloo area and surrounding regions, and also potentially bring benefits to the Northern territory in Australia more broadly as the Beetaloo does have the potential to deliver gas supply, security and flexibility to the Australian gas market if it can be shown to be commercial. As, or more importantly, gas power generation is vital to the security and affordability of electricity supply as the Australian electricity market transitions to lower emissions energy sources.

The specific maters and which we'd like to present to the panel today are exploration appraisal in the Northern Territory and the Beetaloo Basin in particular. Grand water baseline data, oil use and reuse in hydraulic fracturing. Well integrity and barrier failure as well, barrier in particular. The development potential and compatibility with multiple ….. Stakeholder communication and public benefits, and firmly the need for objective or outcome-based robust regulations that avoid our necessary prescription where possible. Of course, each of these areas will be three important themes; consistent themes I think, that the Beetaloo could represent a genuine opportunity for economic growth without the need to sacrifice the territory's unique environment or other industries.

The critical need for exploration and appraisal to be allowed to continue so that more data to assess all aspects of the opportunity and minimise the need for assumptions to be used in these assessments, and the need of course for robust, objective-based regulations and a clear and fair land access framework. I will now turn to the material that I think you are sharing amongst yourselves and hopefully you have access to.

Hon. Justice Rachel Pepper: Yes, we do. Thank you.

Dr David Close: Just see if you're fast enough to get that document. Australia, and many other countries saw an increased effort in unconventional exploration from the mid to late 2000s. Most of this effort in Australia was focused in Western Australia, South Australia and the Northern Territory. Today, unconventional exploration has not provided the technical success to suggest that outside of Queensland CSG resources there is potential to replace the depletion of conventional resources. The interim report on page 35 quotes the 2014 GSI Australia Study that report approximately 12 trillion cubic feet of contingent shale gas resources.

When GSI Australia update that in 2017, which I understand they're planning to, it will show a major downward revision in those contingent resources. That reflects the changing perception of the Cooper base and shale play in particular that would have been perceived in 2014. From 2006 to 2016, which is approximately the period this map represents, the NC did see a ramp up in the area on their exploration permits or applications for exploration permits and in drilling activity. However, even during a time of high oil prices and following the shale revolution in North America that set very high expectations of an abundance of unconventional resources in Australia, the activity was still focused to two to three pretty discreet areas, led to approximately 25 wells being drilled, less than 10 of which were fracture-stimulated.

In the Southern Georgina exploration, as an example, was the focus of a number of companies as the orange area of the map in front of us there. Ultimately, the exploration demonstrated a lack of technical prospectivity and we are unlikely to see, in our opinion, the resumption of exploration foreign conventional oil gas in that play. It's effectively been technically sterilised. This is indicative of the exploration cycle, where most exploration projects do not proceed to development due to some fundamental technical factors, hence despite the high proportion of the territory that is under an exploration permit or application today, it is our considered opinion that very few areas are genuinely prospective. The Beetaloo is one area that has seen sustained activity and encouraging technical results over this period.

It is also the area where, outside of the Amadeus Basin, there has been the longest history of permits, with the area currently held by Origin being under permit almost continuously since the 1980s. The next slide shows a schematic illustration of a road map of the full exploration to development cycle, and it shows where we consider the Beetaloo to be on that path to a potential development. We, and other operators, are in the very early stages of an exploration and appraisal project. The project, as it's currently defined, includes nine wells over a five-year permit term. We have drilled four wells a day with the moratoreum preventing the completion of year three activities.

There are multiple stages illustrated here that precede a development decision, and they take quite some time as is illustrated in the graphic, each of which involves a relatively discreet package of work that increases in scope and budget as the project matures. Each leads to a decision gate toward an exit, or precedes to the next stage of activity. There are also multiple layers of approval required to acquire production licences and developmental project approval set by stay and federal levels, and that's if all of the technical gates are successfully passed. We do hear the concerns that there is an impending rapid move to development from the current project status, which when coupled with a substantial amount of the territory currently under permit has created concern that the industry could grow and spread rapidly.

We don't think that's a likely scenario given the number of potential factors that would limit that preceding rapidly. The 67,000 well calculation by Frogtech, which was undertaken looking at any potential aquiferous stress as part of the Ecola Study in 2013 has unfortunately been used to reinforce this perception, and we deal with this in some detail in our end submission. I'll refer you to that. Although we don't anticipate widespread potential development across the territory, we are encouraged by the results today in the Beetaloo. Turning to the next graphic, it's a cross section from across the Beetaloo Basin and not just Origin's permits. This cross section demonstrates a really important factor, that the positive technical results exist across much of the Beetaloo.

This is critical for economic success, and it's also very relevant to the panel's request for information regarding the need to increase drilling intensity outside of the core area. What this graphic demonstrates is that that core area can be quite large and it would take a very, very substantial development to start to exceed in the core area. Now, we need more data to define what core area means over time and exactly whether there is a sweet spot and where it is, but the initial results, from a relatively limited subset of data, encouraging to show that it is substantial in terms of area. The other thing to note is that the target intervals, particularly what we refer to as the middle ….area, B shale, which is highlighted in the cross section, is relatively concentrated in terms of thickness.

This is idea for containment of fracture height growth, and also in terms of resource concentration, both of which are critical factors for the successful horizontal development. So really positive data from, as I said, a relatively limited subset today. Though largely focused on the Velkerri formation today, the Kaela formation remains of technical and potentially economic interest. It is likely rich in natural gas liquids and condensate that are in a gas phase within the reservoir, but can be extracted changing the pressure or temperature conditions. Such liquids or condensate would improve project economics substantially. The Kaela formation is explicitly addressed as a potential target in our earlier submission to the inquiry.

Our comments regarding the vertical separation are equally applicable for the Kaela and Velkerri formations. As the panel are aware, Origin drilled the first horizontal well under Beetaloo in 2015 and fracture-stimulated and tested that well in 2016. The results of that well, the ….. and W1H well prompted the declaration of a discovery through the local territory government and through the Australian Stock Exchange, and subsequently the recognition of a contingent resource. The contingent resource booking is a pretty important milestone in the basin, but is not, as referred to on page seven of the interim report, known that there are economically viable shale gas deposits in the Beetaloo.

This is a really important distinction between a contingent resource booking and a reserves booking. Contingent resources are by definition only considered to be commercial contingent on some other factor. For example, either market, or price, or some technical factors. They are a confirmation that a technically recoverable resource that could potentially be commercial exists. We're confident to make that statement, and we are confident to say that at this point we know that it could be commercial. The exploration campaigns to-date have largely decreased the volume of the resource as I've discussed, but there is still a substantial amount of work required to convert to reserves.

Most importantly, from a reserves perspective, we don't know yet what a most likely estimated ….. recovery or ultimate recovery per well and a per well cost will be. If the Beetaloo is commercial, though, the consistency of the quality of the reservoir that we're seeing in the reservoir; in the cross section and the map area over which it is known, are likely to be able to provide a long term, flexible gas supply option for domestic and export demand. We understand that a critical aspect of any project preceding to development in the future will of course mean environment approvals. Having appropriate environmental baseline data to seek such approval will as well be critical.

Almost immediately upon becoming operators of the permits in August 2014, Origin began our grand monitoring programme. We have submitted detailed information regarding our programme previously and provided the 2014 desktop study that our programme built upon. As we've stated previously, our programme exceeds the regulatory minimum and we have installed additional monitoring in all wells. There has been some commentary to the panel about the hydraulic conductivity of the Cambrian limestone aquifer, and we do expect that the Cambrian limestone aquifer in the Beetaloo area to have a high hydraulic conductivity, but our data, and existed data show a relatively low hydraulic head across the area. The trans-visibilities will typically be lower.

Our operations at the …and W1H well in 2016 allowed us to acquire data from a relatively localised area. In total, about 10 to 11 mega-liters was extracted from the Cambrian limestone aquifer over a period of approximately five weeks. Log of data from the extractive water boars as in this chart, which is … That chart, sorry, shows how rapidly draw down returns to zero metres after pumping ceases. The chart also shows the water level in a monitoring bore approximately three kilometres via the green line from about three kilometres from the lease. During that entire extraction period, it shows no change in its water level. This data show that in this area, the Cambrian limestone aquifer has the potential to supply substantial volumes without impacting the aquifer level or deliverability even in a localised area.

We'll be showing this data in the written submission. Origin are already collaborating with other operators. CSIRO were able to expand the collection of baseline data. Now this expansion is being managed by CSIRO who are very much at arms length from the operators. Our expectation, if activity is permitted to continue, is that our baseline data acquisition will expand to include other aspects of the environment. Origin does undertake some of its own baseline studies in its areas of operations, but we also support independent studies through universities and research organisations. Establishing the location and extent of any fugitive emissions that currently exist as landscape emissions in the Beetaloo is obviously of critical importance to Origin private development.

It would be a priority for us over the coming years. Likewise, understanding the baseline air quality and biodiversity is critical. We will provide further commentary in our written submission regarding potential methods to complete appropriate baseline studies, and we propose that such baseline studies are appropriately commenced in parallel to ongoing small scale exploration appraisal. Data from such exploration appraisal will be critical to inform the geography of the appropriate baseline studies at a minimum. I'll now handover to Alex to discuss water use in an unconventional development and well integrity.

Alexander Cote: Thank you very much Dave. Good afternoon madam chair and distinguished panel. Thank you again for the opportunity to speak today. Origin recognised the importance of ground water usage, ground water resources, and the importance of proper management around those resources. Assessing water requirements for shale gas development in relation to in areas sustainable yield is an important task, is an important undertaking and one that we are progressing. The risk of stressing the CLA ground water resource in the Beetaloo Basin, we believe, is remote. Research estimating the sustainable yield from the CLA in the Beetaloo area highlights that the CLA is currently underutilised and could easily support the additional draw from the shale gas industry.

It is estimated that the sustainable yield of the CLA in the Beetaloo area is in excess of 100,000 mega-liters a year. Current usage estimates are currently at about 6,000 mega-liters a year. A 1,000 to 1,200 well development scenario as described in the interim report would require 5,000 mega-liters per year at peak demand assuming no recycling of flow back water. Even without accounting for recycling, this would mean that only 11% of the estimated sustainable yield is required to support both the pre-existing and the peak shale gas water demand. Given that there is an order of magnitude difference between the forecasted water demand and the estimated sustainable yield, the risk of overusing, or over-allocating the CLA as a result of a shale gas development is low.

In addition, water levels are, and will continue to be monitored and assessed at both the local and regional scale, ensuring the sustainable management of the resource. Origin also supports quotas and good regulatory framework around the management of the water resource. Next, I'll move on to recycling. Sourcing, recovery of load fluid, recycling and disposal of that fluid are all inextricably linked. The ability to recycle flow back water to use in subsequent hydraulic factor stimulation operations reduces the amount of water that needs to be sourced, and in my mind, more importantly, the amount that needs to ultimately be disposed of. The Beetaloo does not have readily available disposal options.

Frequently used disposal options for hydraulic fracture stimulation fluids includes disposing of the flow back water into depleted reservoirs using injection wells, or quite commonly used in enhanced oil recovery operations, neither of which we really have across the Beetaloo area. It is unlikely that these options will be valid options in the region. Without such options, recycling offers a promising solution. Other areas with limited disposal options, such as the Marcellas, have demonstrated recycling rates approaching 100% of the recovered load fluid. An older panel has been discussing the difference between load fluid recovery and recycling. Load fluid recovery is the amount of fluid we get back from what we put into the well bore.

The percent of load fluid recovery varies substantially from shale play to shale play. It can be as low as 10%, and in some areas exceeds 90%, so it's quite variable. At Amanji, 18% of the load fluid was recovered by the end of the production test. We estimate that approximately 30% of the load fluid would be recovered if we had continued to produce the well. The Amanji values are a single data point, and it's too early to know what the expected load fluid recovery on average for a well in the Beetaloo might be. This is also subject to change depending on factors such as what the go forward hydraulic fracture stimulation fluid might look like.

For example, at Amanji, we used a hybrid system, whereas go forward we might locate using sleek water systems. This could have an impact on what the recovered load fluid percentage could be. Recovered load fluid at Amanji was sampled and analysed. The flow back fluid is primarily ….. with a limited number of geogenic components. Relatively low norms in comparison to North American shales and low detox values compared to North American shales in line with detox values we see in CSG flow back. Origin will be submitting the analysis of the flow back fluid along with a comprehensive risk assessment that assesses both the components of the hydraulic fracture stimulation fluid and the geogenic components as part of the written response.

Our analysis indicates that the flow back fluid would be suitable for reuse in subsequent hydraulic fracture stimulation operations, and that we could expect to achieve a recycle rate in the range of 90 to 100%. In order to recycle water for hydraulic fracture stimulation use in a development scenario, in-field storage will be required. In order to limit the amount of storage required, Origin, like Santos, would plan on operating year round during a development scenario. It was suggested at a panel session last week that Origin would not operate or hydraulically fracture stimulate in the wet season, though it is true that we have avoided drilling and hydraulic fracture stimulations during the exploration phase to-date. This has been primarily for logistical and civil engineering requirements.

For example, all weather roads in the Beetaloo would be prohibitively expensive during an exploration phase. In a development phase, this changes. At the last panel hearing, the panel requested that Origin comment on the contamination of ground water as a result of activities associated with hydraulic fracture stimulation operations, and in particularly in relation to the 2016 EPA report. The EPA report is comprehensive and follows the entire hydraulic fracture stimulation water cycle from acquisition to reuse and disposal. The modes of potential environmental exposure can be categorised into surface releases, during chemical mixing and produced water handling stages, and induce pathways during injection and production stages.

I'll summarise the risks and factors that affect the frequency identified by the EPA, before relating it back to the Beetaloo. I'll begin on the surface side with chemical mixing and surface handling. As outlined in the EPA and the interim report, spills are a challenge for the industry, and there have been spills that have reached soil and surface water receptors. In the EPA report they identified and analysed 36,000 spills reported between 2006 and 2012. Of these it is important to note that only 151 were associated with hydraulic fracture stimulation operations. Of the spills associated with hydraulic fracture stimulation operations, a majority of these occurred due to either equipment failure or human error.

Origin takes the risks to spills seriously and applies a three tier barrier philosophy, to prevent spills from reaching or impacting ground or surface water resources. The first barrier is for prevention. This is all about testing and maintaining the integrity of the system. The second tier spill containment, systems can fail and humans will make mistakes, for this reason we use secondary containment. The third is to be prepared to remediate in the event of the first two barriers failing. If a spill were to occur in the Beetaloo, we're fortunate that the depth of the aquifer and the barriers present presented by clay layers between the surface and the aquifer, along with being prepared just short response time, reduces the likelihood of a spill reaching and impacting ground water resources, in the event the first two barriers fail.

I will now move on to issues associated with fluid migration and subsurface. The EPA identified two potential induced pathways, for fluids to migrate between hydrocarbon bearing zones and drinking water resources, fluid migration pathways along the production well, and fluid migration associated with induced fractures within the subsurface. The primary factors discussed by the EPA the can affect the frequency or severity of ground water impact, as a result of induced conductivity are, the construction and condition of the well that is being hydraulically fracture stimulated, the amount of vertical separation between the production zone and the formation that contain drinking water, and the location depth and condition of nearby wells or natural faults or fractures.

The first thing I wanted to review a special case that was highlighted in the EPA report. There are very few instances of complete loss of well integrity during pumping operations. However such an instance did occur in Killdeer, North Dakota in 2010. The well completely lost integrity during pumping and resulted in 2000 barrel release of frack fluid into the environment. Though this was the first incident to lead to a release, as a result of complete loss of well integrity in North Dakota, data would indicate that at least five …

There were five prior incidents of where barrier had failed during pumping. The cause of these incidents in North Dakota can be contributed to several factors, inadequate casing design, inadequate pressure testing and undefined safe operating envelope and inadequate regulatory review. At the well that failed in Killdeer, the pressure relief valve was found to be improperly set to well above the pressure to which the well had been tested to. The regulator though requiring pressure testing, to be conducted did not review and validate the pressure test on all occasions, prior to allowing hydraulic fracture stimulation operations to commence.

This incident brought changes in the North Dakota regulator. Since the Killdeer incident the North Dakota regulator now reviews all the pressure tests prior to issuing approval to hydraulic fracture stimulated well. There have been no reported incidents since. I believe this is also good demonstration of industry, one sharing their lessons between various regulatory regimes in North Americana and between operators and service companies. Typically when there are large scale incidents, industry typically along with regulators react swiftly. I would like to comment about the process out of …., as it will be different that that was experienced in North Dakota.

Pressure testing prior to hydraulic fracture stimulation operations, is both an internal requirement of Origin and a regulatory requirement in the NT, prior to any hydraulic fracture stimulation operation. Pressure testing was conducted prior to stimulation out of …. The system was tested to 10,000 PSI. The pressure test was not only reviewed by Origin, but the regulator as well before being issued approval. The pressure test is important test as it is used to define the safe operating enveloped ring of stimulation of operations. Most important limit that the operating envelope defines is the maximum line pumping pressure.

The maximum line pumping pressure at Mudgee was set to 9,300 PSI to maintain a safety margin. To ensure that this was not exceeded each hydraulic fracture stimulation pumping unit had an automated high pressure shut off control, as well as a pressure relief valve that was installed on the surface treating lines, that would prevent pressure from being exceeded above the maximum line pumping pressure. I will now move on to the comments about well construction and stray gas migration. The well injection section documented occurrences of where stray gas migration leads to increased methane concentration in aquifers.

The EPA has included the production stage of the wells life cycle, with a relatively short injection stage in the report. I believe this can cause some confusion as it would suggest that these incidents are often associated with pumping operations. Firstly the EPA is correct in their assessment that poor well construction can lead to an increased likelihood in stray gas migration. However the challenge of preventing stray gas migration is irrespective, if whether the well is conventional or unconventional, fracture stimulated or unfracture stimulated, vertical or horizontal.

The examples provided in EPA report included Pathilion and the Wattenberg field. Neither of these plays or show plays and many of the wells associated with stray gas migration and both of these plays were unstimulated. …. from Colorado School of Mines conducted a study, on the failure rates of wells in the Wattenberg fields in Colorado. They grouped and ranked common vertical deviated and horizontal well bore barrier designs, based on risk of multiple barriers failures which is presented, the table presented on this slide. On the left hand side of the slide you'll find a well with, it is a category one well associated with the table, and on the right had side is a well that is a category seven well.

You'll see that there is substantial difference between the designs of those two wells. Further to put this into context, Origin's internal standards would require a well to meet category six requirements at a minimum, during production operations and at least a category seven requirement for well abandonment. The design of Origin's Beetaloo wells align with category nine requirements, which has an even lower risk profile than the wells ………studied. The next slide includes a table of the results of their study. The study shows the wells with appropriate surface casing and cement tops.

Category six and seven have seen no failures in the field to date regardless of their orientation. These findings are repeated by the Environmental Protection Authority. These two primary causal factors of aquifer contamination resulting from fluid migration pathways, within and along the production well which are inadequate surface casing depth, that is the casing is not set below the aquifer and inadequate top of cement, that is the cement is not set above the shallowest hydrocarbon bearing zone. In the Wattenberg field you can see how operators have responded to this challenge over time.

The chart shows the trends of where surface casing has been set and where cement tops are. You can see that over time operators have been continuously setting their surface casing deeper to handle this challenge, and been … Their top of cement is higher. Unsurprisingly this trend aligns with the elimination of new stray gas migration cases cause by new wells seen in the Wattenberg field. For stray gas to occur you need a hydrocarbon bearing formation, a pathway and a drive mechanism.

If we make the assumption that a pathway is present, let us quickly investigate the ability and likelihood to migrate hydrocarbons, or other fluids from where they currently reside to an aquifer in the Beetaloo setting. The portable aquifers that we are interested in protecting from stray gas or fluid migration, are relatively shallow in the Cambrian factors, that will affect the ability for a fluid to migrate include the transmissibility of the formation, pressure differential between the reservoir and the aquifer and lastly the fluid density. Transmissibility is how easily a fluid flows through a porous medium.

Formations that are of considerable concern are high permeability formations, with low viscosity fluids. These pose the highest threat. Fluids are lazy. Even if a migration pathway exists and there is sufficient transmissibility, this does not mean a fluid will move. A fluid will only move, if there is a drive mechanism that is it needs to move from a place of higher relative potential energy, to a place of lower potential energy. What this essentially means is the formation you are leaving needs to have a high pressure gradient than the formation that you are travelling to.

Lastly there is density. Density is important to consider because different fluids have vastly different densities. For example gas is buoyant in oil or water allowing it to migrate easier if a pathway was to exist. This is why gas is far more likely to migrate than brines or other liquids. The brine bearing formations in the Beetaloo or the …….the formations are permeable and the formations can flow brine if the bottom whole pressure has dropped. However there are estimated potential metric surface is below the aquifers. This implies that there is insufficient energy, to move the brine to surface or to the CLA if there were a pathway present.

Origin has identified three hydrocarbon bearing formations, the Chambers River, ……. That is not to say there aren't more in other areas within the Beetaloo that have yet to be explored, but those are the ones that we've identified to date. The Chambers River sand and stone is the shallowest and is likely oil bearing. It has been tested several times on DST, but the transmissibility and the pressure were too low to flow the formation. The formation is thought to also be normally pressured. As a result of the capability … As a result of it being normally pressured and relatively tight, the capability for this fluid to migrate to an aquifer is low.

The ….. are likely over pressured and therefore have the ability to migrate to a low pressure formation such as an aquifer, if a pathway were present. It is important to know though that the permeability's of both formations are very low, in the nano-darcy range, therefore the rate at which gas would be expected to migrate would be very low. The Beetaloo does not have some of the same challenges of permeable gas bearing zones that pose the largest threat stray gas migration. However this does not our well designed or construction philosophy, which is not to provide a migratory pathway in the first place.

Just to reiterate when designing and constructing a well Origin knows where the aquifers and the hydrocarbon bearing formations are. We ensure a minimum of two barriers across the aquifer, and we ensure that any casing string that cases off a hydrocarbon bearing zone, irrespective of whether is a production target or not is cemented to surface. Origin completely agree with this assessment, however it is not applicable to the Beetaloo, as there are no legacy wells that we would re-enter and hydraulically fracture stimulate. The EPA identifies the importance of vertical separation between the target formation and aquifer. In areas where there is little or no vertical separation, between the production zone and drinking water resources, there is a greater potential to increase the frequency or severity of impacts drinking water quality.

The place where this is an issue are typically shallow CBM formations, such as the Black Warrior, Powder River and …… when there can be little or no separation as documented in the EPA report. The practise of injecting hydraulic fracturing fluids into formations, that also contain a drinking water resource, can also affect the quality of that water because it is unlikely that … it is likely that some of that fluid will remain in that formation, following hydraulic fracture stimulation. An example of where this has occurred is the Wind River formation Wyoming.

However these examples aren't exactly relevant to the Beetaloo, given the offset and the fact that neither the …… are an aquifer. The EPA identifies elevated risk levels of hydraulic fracture stimulation fluid migration, into the aquifer in the presence of active suspended or abandoned wells as well. Again these risks are low in the Beetaloo. There are very few abandoned wells across our permits, and we would plan on simply avoiding them by maintaining an adequate offset around them. In the future if development does occur, hydraulic fracture stimulation operations will occur in the vicinity of producing wells.

We believe these risks can be managed, by following guidelines such as Alberta's energy regulators directive 83. The EPA also comments on the elevated risks around faults. However it is important to understand that not all faults are created equal. There are very few large scale geological features within the proposed development area of Origin's Beetaloo permits. Most faults are interpreted to be sub-seismic, between 25 and 50 metres in offset and contained within a particular formation. These faults are not of concern. In the permits there are very few through going faults that penetrate from the …. to the shallow subsurface.

Large faults most likely located towards the edge of the basin will be deliberately avoided as they increase the risk and cost of drinking, and hydraulically fracture stimulating the well. These include the risk of sidetracking and the risk of screen outs. Next I'll comment on well failures statistics. ….claims that well failure rates in the Marcellas are between 75 and 9%. These well failure numbers have been commonly cited. Analysis of the source data however suggest the failure rates reported by …. are overstated. This is of importance because the numbers are used, to directly represent the well failure and releases to environment, not as an indirect measurement or proxy

….analysis of Marcellas well failure rates relies on notices of violation issued by the Pennsylvania Department of Environmental Protection, PADEP. Firstly I applause the use of this data to assess industry and encourage it. The data can be used effectively not only to assess loss of well integrity, but also leading indicators such as barrier failures. However semantics become important here. The loss of integrity of a barrier should not be conflated with the loss of integrity of a well. A loss of well integrity occurs when enough barriers have failed, to allow a leak path that could result in a contamination.

Many of the notices of violation categories included by …. imply a potential barrier failure, but not a loss of well integrity. The notices of violations associated with potential well integrity failures, were often issued pre-emptively during design and well construction phases that is, before any well integrity failure could occur. It's also important to note that PADEP has been commended for their effective and robust regulatory framework, in particular with respect to hydraulic fracture stimulation by the state review of oil and natural gas environmental regulations.

I believe that is a sign of a well functioning regulator that issues pre-emptive notices of violations, when minimum well construction requirements are not met. 97 of the 473 that ….claimed failed did not even receive the notices of violations, but the basis of failure was made from commentary in the inspectors report. In these cases there is insufficient data to conclude that there was a well integrity failure, and the absence of a notice of violation state that there likely was not one. PADEP also requires that operators rectify notices of violation through remedial work.

A majority of the NOVs issued by PADEP had been corrected by the operator, in order to comply with the regulators requirements. Again this was not accounted for in …..paper. …. data also only extends to 2012. Based on the PADEP NOVs data compiled by Origin, the number of NOVs on average has declined year on year. Again we believe that this is likely a function of a good regulatory framework managed by PADEP, resulting in operators that are aware of the regulatory expectations.

All the raw data would have been included in our initial submission. Lastly I want to touch on abandoned wells, because again they're of interest to both the community and the panel. Other than …. surface or contaminants found in aquifers, it is difficult to actively assess a suspended well as it can't be re-entered. What I will say is that the risk of fluid migration and the Beetaloo fluid verging conditions is low. The producing zone at the time that a well is suspended or abandoned, will be depleted and it will therefore lack the energy, to move fluids out of the primary reservoir into an aquifer. In addition to this I would state that there have been over four million wells drilled in North America, over a million alone in Texas and over 400,000 in Alberta.

Though there have been incidents associated with fluid migration, stray gas migration there has been no systemic problems reported or observed. If the risk around abandoned wells was truly problematic or systemic, the issue should have manifested itself already and be easily observable in North America. The map behind you shows, that there are large areas with over 1000 wells per 100 square miles, so we're talking about intense activity that has occurred over 100 years of drilling. Now I'll hand back over to Dave.

Dr Dave Close: Thanks Alex. I'll move on to just discussing a bit more about the economics of shale gas more generally. There are many ways to demonstrate the economic success of the US shale gas industry, and gas prices are probably the best measure. The US has sustained low gas prices since the expansion of the shale gas industry, with historically low levels of drilling, rigs active which is what the chart on the upper left shows. They're very few wells managing to maintain high productivity and keep prices low. This low prices an epitome of success for the US shale gas industry.

It has made it a very competitive industry. The US experience demonstrates that shale gas is not necessarily a high cost source of gas. I think US shale gas is the cheapest source of gas on earth, so I think that's a really important takeaway for us in the Northern Territory. It wasn't predictable at the outset of the US shale revolution that this would be possible, and there's a set of data and wells to prove it, and it's a cautionary tale for any economist or analyst that claims to foresee the economic potential, of several opportunities in the territory. It's simply too soon.

In the chart below on the right you'll see that in 2005 production from shale gas was negligible, and it is growing over time. We had a 45 billion cubic feet much more that 50% of daily production. It is yet to be seen is this experience could be emulated either in Australia or internationally, but there are insufficient data to show that it can't. At the core of this economic success are the efficiencies of horizontal per developments. These efficiencies are realised both in the sub-surface and at the surface. The montage of maps and aerial photos on the next slide, shows a reasonable analogue for what surface impact could approximate in the Beetaloo.

These images are from Eastern Ohio, where over the last five to six years the ….. shale play has emerged. This particular area has not previously had conventional oil/gas developments, which is relatively rare in the US in areas where unconventional plays have evolved. In these images the relative limited surface impact is clear. The lack of existing infrastructure related to conventional developments is a bit low honestly. In the bigger loop Origin has access to large continuous land tracks as part of our permits, and therefore can optimise development and avoid the patchwork type developments, that can occur in some areas in North America, where operators have limited continuous land access.

The next slide shows an example of what the Beetaloo will not look like. The Beetaloo will not look like West Texas or South Texas. This image or similar images are used by those opposed to onshore gas, to imply something that is not reasonable and would certainly not be economic. The stereographic chart that I've included, that is from the same area where the photo is from in south Texas … The stereographic chart is for the USGS, shows that there are more than a dozen oil and gas targets in this area, and there's decades of development of both oil and gas from different reservoir levels.

The recent Eagle Foot shale development is not the primary contributor to the development in this area. It should also be noted though that across South Texas and much of Texas, ranching of cattle and oil and gas developments co exist successfully, and that tourist attractions and recreational hunting operations in the area, continue to operate successfully and have done so for decades, so if there is where this kind of development is the norm, it has not impacted the other industries unnecessarily. In the next slide we talk about the development … We show the development scenario outlined in our original submission. It includes approximately 400-500 wells of 60-68 pads every 20-30 year period.

The pads basin development is asymmetric and is the function of well length and regional stresses. This is relevant to the recent request for information regarding the minimum spacing of pads. The number of wells and pads that are in development is a function of a number of factors, technology, how far we could drill, the year you are per well, what the market looks like, what the access to market and the pipelines that exist. Both are needed to provide a multi-town development plan. We don't support a prescriptive minimum pad quantity or spacing.

They could very valid surface constraints that impact pad placement decisions, and the objective should be the overall impact minimization, both on the environment and on other land users. Other varying well based estimates that the inquiry may oversee, we would put that such estimates can be built with different assumptions. Different proponents may model well results the same, but overall demand differently or vice versa. The primary economic drivers however will be similar, and are primarily the estimated recovery per well, the liquid from the gas drain and the cost per well.

Again we reiterate that the US experience should provide pause to any person, that claims to know the Beetaloo or other territory plays that are none-economic. On cost it's important to note that no optimised development would include in-field drilling or fracturing. Such activities would typically worsen economics in the same play. A success case would create supply diversity and critical flexibility, and a little bit on that will Beetaloo be a success? The next table I will not attempt to go through every row, but what I would point out and a number of key technical factors, the Beetaloo does compare favourably to six successful plays in North America. I think that's worth noting. Of course there is still further technical data required, and as well as the technical data required there are numerous non-technical challenges that are made, and I'll hand out to Stephanie to talk further to some of these issues.

Stephanie Stonier: My name is Stephanie Stonier and I'm Origin's corporate affairs manager for Northern Australia. Based in Darwin I support our exploration assets both on-shore and off-shore in Northern Territory and Western Australia. Today I will comment briefly on a small number of elements in the interim report. Our observations will also be included in a written response to the report, and the most recent I've received from you Madam Chair. Firstly we'd like to acknowledge and thank the Chair, the deputy Chair and the panel members for their work today.

The interim report has comprehensively looked into both the perceived and natural risk of impacts in our industry, and we consider the report to be a fair and reasonable representation, of the current state of community sentiment in the Northern territory. We pay particular respect to the extensive community consultation that has been undertaken. We see this particular component of your work of holding high value. As our pride is conducting small-scale activity in a discreet area, we have to date limited our interactions to our directly impacted stakeholders.

We have not sought to enter communities where we do not operate, nor have we sought to go into communities in the absence of an invitation to do so. On this not we would like to share with you our approach to stakeholder interaction, relating to our nine exploration wells as per our commitment to the Northern Territory government, required under our five year exploration work programme. Whilst we agreed that there is more that industry can do to share information more broadly with communities further afield, from where work is being carried out, for our directly impacted stakeholders we believe we have strong local support and partnerships.

Origin believes that it is important to understand and employ different types of stakeholder interactions, at the appropriate time and extractive projects, exploration to production life-cycle. These important differences we distinguish between and describe as communication, consultation and engagement. Communication in the current context and in the point in time of our project, we treat as the transfer of information about an actual or proposed activity, without an expectation of a direct response. Communication will refer to as a push process. Consultation we see as provision of information, whereby we are seeking responses to an actual or proposed activity.

Consultation is a two-way process. Engagement we consider as being an exchange of information, where related parties listen to concerns and suggestions. It is the approach which provides for co-design of an actual or proposed activity. Engagement is a process of active consideration of any concerns and suggestions about the design, execution and operational parameters. It is a two-way process, involving a business to business relationship that incorporates the concerns and requests core land users, in the planning, executing and ongoing management of activities.

Collectively we refer to these three stakeholder approaches as stakeholder interactions. We believe it is of vital importance to understand the purpose of each of these, and how we afford at this point in time strong waiting to our core land users and landholders. We are of course each other's directly impacted stakeholders. Since Origin began operating in 2014, our exploration permits … Sorry. Since Origin began operating in 2014, our stakeholder interests have been primarily focused with engaging with our directly impacted stakeholders. To be clear we refer to those as our host traditional owners, our host pastoralists, the local business owners and daily warders and the Northern territory government.

We consider this area of stakeholder focus at this point in time in our project, to be correct and to be correctly weighted. Given that one it is only by working collaboratively with these business partners, can we jointly realise the opportunity of our exploration acreage, by being able to conduct the necessary work that secures to then be able to communicate and consult more broadly, into the region and across the Northern Territory. Two, it is aligned to the scale and level of impact of our activity, which to date is four exploration wells from three wells at locations.

With the above stakeholder interaction context provided, I now turn to specifically addressing an element in the report on page six where I quote, "It is the panel's assessment, that Aboriginal people have not been given enough information about the potential risk and benefits of hydraulic fracturing. It is imperative that accurate information is provided to Aboriginal groups, likely to be directly affected by hydraulic fracturing, well in advance of any decision they made. We agree with this statement however we also offer that for the Aboriginal people who are host traditional owners, with the rightful cultural authority to make decisions in relation, to what does and doesn't occur on their land, have engaged consistently with us and have a good understanding of exploration activities, culminating in their consent for each exploration well which has been executed."

Origin follows the prescribed process of engagement with traditional owners, both through and with the statutory representative body the Northern Land Council. Moving through the interim report page 119 where again I quote, "There can be no doubt that the absence of the right to veto at the production phase, places traditional owners in a difficult position at the exploration phase, which is the only point in which they can exercise their veto right, because the information that is available with respect to production at the exploration will be very limited."

Our exploration acreage does not fall within the land tenure boundaries of the Aboriginal land right set, so whilst this observation maybe accurate for exploration permits, or for mineral resource projects on our land, this statement is not universally accurate for permits on native title or aboriginal freehold land. Exploration agreements are in place between traditional owners, the Northern Land Council and operators, which provide consent for exploration activities only. Clause 11 of our exploration agreements, we have two and the tripartite agreement and associated sub-clauses, prescribe that consent is required for any and all production activities, not the least of which is that a production agreement must be in place prior to development activity.

Origin is mindful and respectful of the confidentiality clauses in these agreements, and we respectfully request or suggest Madam Chair that you seek the support of the Northern Land Council to assist you in securing consent, from the exploration agreement parties for you to be provided copies, as evidence that traditional owner consent is required prior to production. With regard to pastoralists, hosting Origin's exploration and activities on their leases, we would like to resubmit and confirm, that we have not conducted activities on any property that our acreage shares with other land users, whereby we have not reached an access and compensation agreement prior.

This is a case for our three wells at locations, as well as negotiating access and compensation agreements where infrastructure such as airstrips and roads may cross, or be located on another station or another property. The existing guidelines provide that the Minister would not approve an application for activity, in the absence of pastoralists consent. Origin supports this guideline provision being legislated with the appropriate dispute resolution pathway, being understood and accepted. The last decade has seen an increase focus on the onshore sector of the industry, and as we learn to share and co-use land, to yield maximum benefit from the natural resources both at surface and at subsurface.

Origin serves for a notion of development in Beetaloo, describes approximately 50-65, 140 metre by 140 metre well pads, which would take approximately 20-30 years to install. What we seek to illustrate here is that a notion of shale gas development, is not of the scale nor nature that would be detrimental to other land users, nor do we consider that would remove or dilute any other industry's ability, to continue to operate and contribute to the entry economy, and provide Northern territory jobs. Primarily in our prescribed area in the Beetaloo, this statement refers primarily to cattle and to a lesser degree the agriculture and tourism industries, which are more prevalent to the north of where the prospective gas basin is.

We consider multi-land users, being a sustainable model that could deliver collective net benefit to the Northern Territory. This view aligns with the Queensland Gas Fields commissioner is finding, in that landholders are key business partners that enable natural resources to be developed on behalf of the state and the community, and that there must be mutual knowledge of and respect for each other's business. It is our view that this is an accurate statement that acknowledges the fact that, there is a property right and a subsurface resource right, and that each carry important value and merit for the community as a whole, and that one should not be treated as superior to the other.

The business to business commercial arrangements between multiple land users should be allowed to flourish, between the affected rights owners, providing a veto right for one over the other or regulating to prevent access to resources like water or gas, does not honour the fundamental principle of equality and rights. The commissioner also recommends, that industry must engage early with local government, to help counteract its initial community impacts and build a stronger future together. Origin committed in its first appearance before this very panel, that should we arrive at appoint where an economic and sustainable development is a proven proposition, we commit to working collaboratively with community and government in advance of such development.

The commissioner also strongly encourages that discussion, engagement and decision making about all aspects of the industry, its impacts and its benefits be granted in factual information and not in emotion, especially the sciences of geology and water where there is contradictory information, being distributed throughout the community. Perhaps this type of work relating to the provision of factual information, could fall within …. of an independent anti-shale gas commission. Origin considers it prudent to invest in and establish a dedicated body as soon as possible, with a clear role in facilitating interaction between industry and community, where all parties are held to account for the information disclosure and content.

Perhaps this will assist in reducing the non factual information in the community, which is a genesis in some areas of substantial stress, divisiveness and a concern. We continue to be encouraged by the opportunity that a safe and sensitive development in the Beetaloo, presents for growth in Northern Australia, that we must responsibly reaffirm our previously state position that it is critical for further exploration, and appraisal activities to be carried out. It will allow operators on behalf of the territory, to gather the data sets that will ensure that it is factual information that guides policy, and decision making.

The substantial body of data collected where could obtain with each stage of exploration, appraisal and delineation must be undertaken before any development sanction could be considered. Any delays in undertaking this work further defers the economic opportunity for the Northern Territory. We maintain that a development in the Beetaloo, could deliver both direct and indirect jobs, provide economic stimulus through private investment and return royalty revenue to the Northern Territory. The Northern Territory's natural gas resources could further more; potentially underpin energy security in Australia for decades to come.

We take seriously the environmental and multiple land use concerns as stakeholders. We are committed to understanding these issues and demonstrating safe and responsible operations, in order to assist in building community confidence and trust, in our commitment and our capability and identifying, managing risks and executing activities safely. Should this scientific inquiry find that hydraulic fracture stimulation, can continue to be executed safely we do not support the following. We do not support a prescribed and limited season of operation.

We do not support a vote of veto and we do not support prescription on well, pads basin and separation. Whilst the existing legislative and regulatory framework, in the Northern Territory continues to serve and be appropriate for the current and future exploration activities, we do however support fit for purpose improvements, which align the regulation to the geology and scale of the non-conventional gas pipe development in the Beetaloo. Some examples include that Origin support, a holistic water management regime for the Northern Territory, whereby all industries and users report their usage that we support the legislating of the current guideline, which provides for land holder consent being obtained prior, to the Minister approving applications for activity.

We support improvements such as codification for well integrity, and we support the concept of exclusion, and or no go zones with acceptable buffers for the explicit purposes of protecting national parks, sacred sites and sites of culturally significance to name but a few. We cannot understand that it is continuance of prescribed exploration and appraisal activities, regulated under the existing act and regulation, which will allow collected data, to scientifically confirm the technical assumptions of the size of the play, in terms of recoverable gas. It will provide inputs that can inform the economics of the resource, based on volume rate and composition of gas.

It will provide factual information and data, to design what an actual development could be replacing the current situation with only notion of development scenarios. This data would inform actual risk and provide for the design of appropriate and specifically engineered controls to mitigate, manage or remove those risks relevant to the specific science of the prescribed geology and water profiles in the Beetaloo, and it will meaningfully inform the type and nature of recommendations, that will help build a fit for purpose regulatory regime in the Northern Territory.

We have endeavoured to touch today on a range of issues highlighted in your interim report, the most recent are five and material presented before this inquiry during the public hearings. We thank you madam Chair and the panel for the opportunity to appear before you again, and be able to present our information and observations. We would be pleased to take your questions.

Hon. Justice Rachel Pepper: Thank you very much. Thank you very much for your detailed presentation and further information, provided upon request to the inquiry. I just want to get one thing clear, and to just show you shouldn't always believe what you read in the paper. The seasonal operational and restriction, what exactly are you not supporting or you are supporting, because there seems to be some confusion.

Dr David Close: Perhaps I can add to what … At the moment we're being limited not by any technical limitation to go into the wet season, and exactly what defines the wet season in the area we are is an interesting question, we find ourselves that we don't find cyclone activity, very serious storms. The highest risk we see is damaging pastoralists' rights, so we don't … Not just all its brand new equipment, at the end of the day we don't wan t damage to get out. We don't anticipate any specific problem with the wet season that couldn't be handled. The obvious one we would reflect, that we would look into is how to manage a free board in the open storage, or you could go to entirely closed system.

The highest annual rainfall in a year is 1,182 millimetres I believe, and the bureau of meteorology frequency, intensity, duration is three day period, is about 380 millimetres for that three day period. There are more data sources we could use to put a safety factor, design factor. Does that answer?

Hon. Justice Rachel Pepper: I think so, so effectively I just find saying correctly and please do feel free to correct me if I'm wrong, is you would … I think it's sensible to have or good idea to have a restriction for seasonal operation, in relation to exploration but through scale, production development.

Dr David Close: If a proponent was prepared to invest in the roads in particular such that they weren't damaged, there's no prescriptive reason to prevent the drilling and fracture stimulation activity. There's nothing in the wet season that makes the drilling a different reason for, or the hydraulic fracture stimulation. I think for year round operation it's a really a balance of … At the moment it's balance of expenditure versus the scale of the project, that we're investing $4 million into a site versus waiting three months to access it after the wet season, is the proposition that we have. We only have a couple of wells to drill for a year, so the right rational logistics, decisions is to wait.

Hon. Justice Rachel Pepper: I think I may have read something different reported in the paper that's perhaps was taken out of context.

Dr David Close: Yeah, I think I've read the same summary. I did do an interview with ABC where they put that question to me directly I think to the report. My response as I recall and I think the transcript is there, is that we believe in objective-based …… as appropriate for any kind of operations, and then went on to expand the different winter, wet season operations we could get hopefully that would reduce that risk entirely, but if we weren't able to operate in the wet season for some reason it wouldn't necessarily prejudice the commercial possibilities of the project. That might not be optimal, and we wouldn't necessarily suggest that should be prescribed.

Hon. Justice Rachel Pepper: Yeah I see.

Dr David Close: It wouldn't necessarily that you can't go ahead.

Hon. Justice Rachel Pepper: Trade offs to social licencing and things like that. All right. The well density, there seems to be a lot of confusion about … I appreciate that you have given us your best estimate at this stage for the area that you are looking at, but obviously you're aware of I think a departmental estimate up to 6000 wells.

Dr David Close: Yes.

Hon. Justice Rachel Pepper: Do you have any idea … Can you explain in any way the vast discrepancy between your estimates and those of the department.

Dr David Close: A fundamental different view on what the market could be and how you'd access that market. As a fully integrated agent campaign that has a lot of interest in pipelines, we are pretty in tune with what's possible, what's feasible. We don't anticipate that that high end bar, is an economic proposition of the pipeline company in the current environment. We would not see sufficient pipeline capacity into that basin, in the time-frame, a reasonable time-frame to consider for economic modelling that will allow that type of development to occur. We just say that there must be some kind of fundamental difference, about how the estimation where that gas is going to go.

I think what is in the interim report was a combination of a couple of different proponents. It's probably about the scale of what could be reasonable. I don't see people clamouring to build a second line, only gas pipeline.

Hon. Justice Rachel Pepper: Not a current customer.

Dr David Close: I think the reality is that the higher end won't be …….The discovery may support a much bigger, larger number of wells than we have.

Hon. Justice Rachel Pepper: You've corrected the last question for me before I let the person listen. You have correctly identified and spent some time on well integrity, and you would know that this comes up time and time again in consultations, and quite a valid point is made by the community which is to quote you Dr. Close, "Nothing lasts forever," and people are quite concerned and we are concerned, about not having adequate data going forward say 50 years, 100 years, 500 years whatever that may be. What's your response to that?

Dr David Close: Yeah. I'll get Alex to speak to that.

Alexander Cote: I guess part of the question would be around the materials that we select to construct a well within the first place. What I can say is that materials that we do select are specially engineered, to be able to withstand the conditions and the fluids that they'll come in contact with. One of the things will be including in our written response will be some literature, providing evidence around the testing and the like that has been done on various cement blends, to demonstrate their suitability for the conditions, pressures, temperatures and time periods we're expecting these materials to last.

Lastly, I guess what I would put again is, just because there is in a very worst case scenario, just because there is a pathway again doesn't necessarily mean, you're going to have migration or contamination event. You do need the ability to push a fluid be it gas or liquid from one spot to another, unlike areas in the US where and I think Dave set an example where you have 10, 12 different height or conventional gas reservoirs stacked on top of each other, which prevents substantial challenges and operators in those areas have been able to overcome them.

We have very limited number of hydrocarbon appearing zones, three to be exact none of which are conventional of nature. The ability for fluid to migrate is substantially lower than in other areas, which is to our benefit. That's not to say again we will construct these wells as if they were a well that was going in any other play in North America, Europe, Australia to be able to handle time.

Hon. Justice Rachel Pepper: Thank you. Sorry, one last question from me I promise. In the jurisdictions in which you operate booth here and overseas, what in your view is the toughest regulatory regime or most hardest, the most expensive if you will to comply with?

Dr David Close: Queensland has a very thorough and recent regime and heavily conditioned on the CCSG projects. I would put that as my across the board comprehensively mostly so, but I would have to check more broadly with colleagues if you want to do some in New Zealand, Southern Australia, Western Australia, Queensland. A simple answer would depend on different elements of how industry is regulated. In New Zealand there is already independent assessments or voluntarily.

Hon. Justice Rachel Pepper: That's a fair response which does depend I think on which component you're talking about. I notice for example I think Alberta, one of the Alberta …. in relation to well construction as quoted. I will start this way and go down this way. Yes, Professor Priestly, thank you.

Professor Brian Priestly: Thank you. I have two questions, one of which you may already be in the process of answering and the other is a new issue. The first one, in your original submission you've made reference to a risk assessment being done on the Beetaloo Basin. This was referred to in part seven of the questions that were referred to you. I got the impression that we're still waiting for that health risk assessment report. I wonder if you can give us an indication of when it's likely to be available, because it would be useful to have that before we get too far in writing our final report.

Dr David Close: Yeah, certainly. We are in detail drafting it and it's mostly around promising some of the context. I think we can expect to at least give a summary and the data part of it with our re-submission, and the full risk assessment will be able to give at the same time. It is very comprehensive. We're working … One of the challenges over the next period of time will be working with consultants, then along with companies are dealing with data for the first time, and so to be very thorough about it does take some time. It is still very much a priority and it will be submitted as soon as we can …..

Professor Brian Priestly: It would be very useful to have that because the methodology that I anticipate you be using would be relevant to what we're proposing. The second point I have relates to an issue of flaring, gas flaring. We've heard references to financial impact of gas flaring on communities, particularly for the Queensland situation. I understand that in Queensland that relates to CSG production and there might be some differences. There are obviously some similarities between those two forms of gas extraction, and in particular in relation to flaring I would imagine there would be a lot of commonality.

Could you perhaps outline the approach that you propose to take, the management of flaring operations in shale gas operations in the Northern Territory. Where would the flares be located? What sort of frequency would you expect them to occur?

Alexander Cote: Happy to do so. First off during the exploration phase flaring is necessary to test the well. There is no infrastructure at the moment that we can readily tie into, so part of being able to assess the reservoir, at this stage means that we need to flare. During exploration phases where wells are not tied in, flaring is going to continue being the safest way for us to test the well. During production or development phases what you'll find in most North American shale plays, is you flow back in line. That means essentially as soon as we start flowing back, you're flowing through your initial separation, and your gas is going directly into the pipeline.

That means we still we'll have, we need flaring ability for safety during drilling operations and completion operations, in case we have gas that flows on us. You'll still have a flare that's required at a plant site, but flaring as far as testing prior to putting the gas in line, I would anticipate that a good operator should be able to eliminate that completely. There should be a push to tie in line. That is what I am familiar with working with other operators as well. That's how we operate it, so in line flowing as soon as you're done stimulating the well would be the way that you would minimise flaring.

Professor Brian Priestly: Thank you. I guess the bottom part of my question for this, do you have any air marker that would inform any health risk assessment?

Alexander Cote: We definitely know the composition of our gas that would be flaring off. I guess there were past questions about what the actual efficiency of a flare is, so I guess that means are we actually burning all the hydrocarbons, that is passing through the flare system, which I can have a look and put a response back in our written submission if that works.

Dr David Close: I think Queensland is ….. for what it might look like. You can now go online and see how they're updated their quality, the number of stations across the …. basin. Reasonable expectation there might be something similar in the future if development was to go ahead, so that you could see any changes relatively real-time.

Hon. Justice Rachel Pepper: Dr. Andersen.

Dr Alan Andersen: Thank you. I've got questions over three issues that I would like to ask. The first one is just basically between well pads and you've expressed a concern, about specification of minimum spacing between well pads. You shared this photo of this Texan situation and how it wouldn't look like that, but if well pads were at that density they would look like that, and so I was wondering why the concern of setting some minimum distance is, and if they weren't minimum distances set, how could the community have confidence that it would look like this?

Dr David Close: I guess it depends on scale a little bit. If it was to say that they cannot be within 300 metres or, I'm not sure exactly what the spacing is. it probably wouldn't see any resistance necessarily, it probably wouldn't be a regulation that would have any impact. If that was part of the ….. what would make it acceptable, it may be something that would not be actively contested. I think if it gets to the point where you're at the margins of what you expect you're going to be and it's prescribed, you are limited perhaps with opportunities of where it could be most optimal in place to limit the impact on the line wide system of pastorals or primary watering or yard of a pastoralist.

You would most likely be able to manage it but there could be instances where it's not optimal because you were limited by the prescribed distance. I don't see it meeting objective. I think if the objective is to minimise overall impact and you have a competent regulator or an agency that does your approvals, they should be able to challenge you on or ease that private spacing in that area and ask you to show why. Likely you'll see innovation at the time that decreases it even further than what we anticipate today. It's not an objection that … I think we all stipulate that is not what it will look like …..economic on that basis and we're not planning to do verticals.

If we start prescribing on everything that can be, can become …. some of the old parties without adding a lot of benefit potentially, that's the only ….

Hon. Justice Rachel Pepper: What about the benefit to the community of not having an industrialised landscape which we've had time and time again as a concern?

Dr David Close: The objective we would absolutely agree is to ….It depends again on the exact nature of the number. If it is to be one per two square kilometres versus one per 15 square kilometres. Like most things, it would depend on the detail of how it was going to be prescribed. I think if it's to minimise impact and for the direct ….. to be particularly concerned over that presumably who was part of that approval process, there are fairly strong protections in place currently. Approval needs to be given for each …… I guess it's hard to comment without knowing the detail of what the proposal will look like.

Alexander Cote: Just to add on that, with our developments there is an asymmetry. In the direction that we will be drilling in, you would expect the spacing to be greater than the direction perpendicular to that. Our ability to drill off and then forward is more limited than our ability simply to drill forward. I'd agree with Dave, better understanding of what the proposed minimum might be and how it might affect your ultimate pad spacing would be a benefit to us to understand as well.

Dr Alan Andersen: The second issue is to do with traffic levels. We all know that fracking involves a lot of truck visits, maybe vehicle visits. It's an issue for both amenity. Normally when we talk about amenity impacts we think of the land transformation beside what we've been discussing. Of course another important part of amenity is for the residents living on towns on the main highways. In particular tourists who are coming out to experience the great iconic NT outback. What they don't want to be doing is stuck in convoy after convoy of heavy vehicles. I was just wondering if you've modelled at all, done any modelling at all of traffic requirements associated with these

	scenarios and phases that you've shown us. Maybe if you could just take that on …..
Stephanie Stonier:	Dr. Anderson, we haven't done modelling on a development scenario explicitly yet. What we can share with you is the modelling we did for your exploration activity which we submitted to the regulator as well as consulted with the department of transport on and had them assess the number of vehicle movements, the type of vehicle movements, heavy vehicles, light vehicles and overall what duration window. We then also had to share that information with the department of tourism to understand that if they thought that there was going to be any material impact on tourists using the Carpentaria highway and the Stuart highway. We're very happy to share that information with you. In both instances, in terms of feedback from those three agencies, they deemed that level of activity to be marginal and not of concern and subsequently endorsed our traffic management plans for that activity.
Dr Alan Andersen:	Thanks for that. That's for the exploration phase you've done. Obviously if you're scaling up it's going to be quite a bit …. If you're able to scale up those figures possibly on your submission, if you could do that, that would be really good.
Stephanie Stonier:	We'll attempt to model that for you.
Dr Alan Andersen:	Then associating question. I don't know if you've given any thought to this. One mitigation option possibly would be to use railing. Is that something that's considered and ….
Dr David Close:	Absolutely. Given the Darwin port is a pretty major existing port facility connected to a rail network that goes very close to the permit edge. It would seem like a very logical way to alleviate, minimise cost, alleviate impact on other users. Much of the material such as ….and so forth will only come out of steel ….. in Asia and be one of the competitive advantages we have say over the US is that we're actually close to all of those supply routes. I think rail will be an important part of, certainly of the imports. That would alleviate that problem. How to model that is something we're discussing with some of the people in our projects team and we'll certainly work on coming back with a more detailed reply.
Dr Alan Andersen:	My final question is something that the panel has just been alerted to recently. That is this thing called radial drilling as an alternative to fracking. Is that something that you've come across? We've read a conversation piece on this, that's all we know about it.
Alexander Cote:	If it's what I think it is, and I'll come back with a more thorough response. We're dealing with such tight rocks that the amount of surface area that we need to create in order to effectively produce the shale, you would never be able to achieve through a drilling technique. The only reason these plays are viable is the extensive amount for surface area that we're able to create to

compensate for your 10 to the -9 permeabilities. I will take a closer look at exactly the technique that they're suggesting and I'll provide some commentary and a written response.

Dr Alan Andersen: Apparently ….

Alexander Cote: I'll have to take also a look at what type of assets they're applying that technology to. It might be a plate that has significantly higher permeabilities than what we're dealing with. I'll happily take a look at that and provide some commentary.

Hon. Justice Rachel Pepper: Yes, professor Hart.

Professor Barry Hart AM: I have four broad areas. First of all the ….. resource and what is known about it. You put up the commonly quoted recharge, right? 100,000 mega litres per year. We put in the interim report that there's another couple reports that go from 100 to 330,000. Question one is, do you have any additional information … that's come from the department, all of that information. Basically it's been redone and redone by various consultants. It's essentially the same information. I can't find anything at all really about the age of the water which is related to recharge. We've got information on the passage, the Northern going across the Roper and also to the Daily. Nothing in terms of rate of passage. Which for the Roper people particularly … we've just had some presentations on that area.

The importance of the springs and the Roper River and so forth. That's a crucial question. I seem to recall some information…… I haven't been able to pinpoint it. it's the order of 300 years. If you've got any information on that we'd really appreciate it.

Dr David Close: Most of our information is in the …. study which did summarise a lot of that. A lot of source data as you say is that Northern Australia's …. project by CSIRO around 2009. We do have a reasonable head map across our permit areas. That's about 100 kilometres South to North. There's about three to four depending to whether you're on the edges.

Professor Barry Hart AM: Say that again.

Dr David Close: Across our permit, the head range is about three to four metres.

Professor Barry Hart AM: North to South. Down to Elliot?

Dr David Close: Higher towards the South, lower towards the North. Supporting that northward flow in the …. limestone aquifer. A relatively low head compared to … we recently sourced a …. from Katherine and the head between say just a bit … honestly a bit of work going on at the moment. Both …. Tindal and the Katherine River required a high head over a relatively short distance. We see a relatively low head over a larger distance. We expect our transit times to be …. we're seeing in this region. That's very much one of the focuses of the….. road studies. We're looking to find well pairs which are that easier to find that would be appropriate for ….studies to try and start. I it might take us a number of years because of how slow it is.

I suspect in time we'll rill a purpose built monitoring network for understanding the ground water baseline. It would take…..to start getting the real data to answer that question. I guess what we can say it's not faster than X because we would see that more rapidly. It is in the order of the hundreds of years. …. most of the recharge for the Roper River. I think it's other studies by the department show limited radius around the Roper River where recharge comes from.

Professor Barry Hart AM: That's true. If you take the 100,000, almost all of that information is in the Northern part of …… We haven't been able to find anything that relates to potential recharge in the Southern part. It's got to be less. The rains-

Dr David Close: That far, it's not substantiated between Elliot and …….

Professor Barry Hart AM: It's a substantial change in the rainfall load.

Dr David Close: Okay, I'll have to go back to my …..maps.

Professor Barry Hart AM: That was the first one. We see that as an important set of uncertainties. The second question that I have relates to the reuse of the flow back water. Thank you very much for the updating, it's been all over the place in terms of the potential. I think it was 90 to 100% that you suggested was in your ballpark in …… which is-

Alexander Cote: Correct. Of the returned fluid that we're able to recycle.

Professor Barry Hart AM: Which is very good. Two questions I'll have with that. Is there a need for any treatment of that flow back water before you can reuse it?

Alexander Cote: We took a sample and we tried to make the exact same fluid, the same properties that we used and we didn't have any issue creating again a cross linked fluid. One of the questions moving forward will be, do we continue with a hybrid design or do we move towards a sleek water design? There was very specific reasons we had to go with a hybrid design. Part of that was down to the well board design. As far as the salinity values, the salinity values weren't high enough to cause us an issue. Keep in mind also the flow back water would need to be blended or would be blended to supplement back up to the volume that's required. We believe that if we were just to use the flow back water that we recovered at ….. and if we're able to get enough of it to do a whole stimulation job, we could simply use that fluid.

The fluid's properties will only improve once we start planting back down.

Professor Barry Hart AM: Presumable there's a minimum time that you can keep reusing in a …..

Alexander Cote: Once you get too many dissolved solids and stuff in there, typically what will happen is you'll have a series of retention ponds and you'll move water from one to the next. In plays that I have been, that I have worked in, we haven't needed any elaborate filtration systems or anything of the like. Usually time and settling was our strategy of choice.

Professor Barry Hart AM: ….. with other types. Shandy, mixing with other possibilities. Sorry,…..Third one relates to hypothetical of … I know what you've said about the, from your perspective at least low risk of contamination of an aquifer. Let me put to you if it does occur. What remediation methods do you have available to you?

Dr David Close: The specifics of the event would be important. A surface spill of flow back fluid versus later in the production's life cycle where methane is your only really available contaminate. Methane, if you did detect that there was any stray methane you would still have, if it's a producing phase the ability to …..remediate that well. Added methane over a short period of time would have a short life in the aquifer because it's highly mobile and it's buoyancy is how it would ….Anything else required other than that time. With flow back fluid, it's most likely going to be non aquifer title or comprehended scenario versus an aquifer contamination event rather than a surface soil or near surface event.

You would, depending on the scale, put the right monitoring in place. Look at what the extent you're expected to be. If it's mobile, is removal and or treatment of the material, the right action at that point.

Professor Barry Hart AM: Removal, how?

Dr David Close: If it's a soil based event ….It would have to migrate very quickly to be an issue into the grand water. If it did make it to the grand water, the front will have expanded substantially such that surely the dilution is reasonable. Again it would depend on exactly what we're talking about. If it was flow back fluid I think that would not, from what we've seen, there were no lasting environmental legacy from that. Obviously you had to sustain probably across the development that would be an issue. If you're talking about a single one off incident, we don't expect that will create any kind of environmental legacy.

Professor Barry Hart AM: Just one more. I've got a couple on the waste water which is what we have been talking about, flow back water. Just going back to what you said before which worries me a little bit. If I can paraphrase it you say dilution's going to fix it. Dilution's the answer to pollution. I don't know what you meant but that's the way it came out to me. I think that depends very much on … what are you going to do, what do you anticipate doing for the monitoring? That's the first thing, you've got to know it's there. That's why I asked the question about the flow path and the rate of flow paths. If you're right about the dilution, that is very much tied up with … That you've monitored down flow path and that there's enough flow that you will in fact get dispersion.

I see a number of issues there. You don't have to answer now. I'd appreciate that. Certainly if you take that on board and-

Dr David Close: Yeah, I think we are doing some detailed balling based on your… at the moment to look at what it would look like in terms of if you had ….different scales. I think whether it's a pipe for us to not know it had happened, we have to put any kind of time lag, we have to think of a scenario where it could occur without immediate knowledge. We can just assume that gap exists for the purpose of…..

Professor Barry Hart AM: The reason I'm asking this, I asked Santos too, is that the contamination of water, use of too much water but contamination of grand water is absolutely key on everyone's mind. We want to get as much information as we possibly can from the companies as to what they potentially can do about it, nothing or lots. Okay, you put in place all of the methodologies to ensure it doesn't occur. As everyone knows, these things do happen at times. What can we do about it? That's why I'm-

Hon. Justice Rachel Pepper: It's a particular concern with decommissioned wells. Time and time again the question's asked, well, look, okay, well's been decommissioned. Let's say that hypothetically speaking there is a failure that results in methane seepage into the aquifer. How do you: A monitor to see whether or not that is occurring? If it does occur what happens?

Stephanie Stonier: I think we have a better understanding of what you're asking us to respond to. We will include some scenarios in surface builds of frack fluid, a diesel spill at surface, how you would deal with that as well as potential contamination through the pathway of the well bore and get that back to you in writing.

Hon. Justice Rachel Pepper: Thank you. That'd be useful. Including monitoring, that would be, that's quite critical, thank you.

Professor Barry Hart AM: The last one again on the water you've gone through and you'll obviously go through but more detail in terms of collection, storage, treatment, potentially and reuse. What I wanted to ask was whether there's been any discussions between your three players, you Santos and Pangaea about a coordination. I'm think probably more about if there's a component of treatment. Doesn't seem to me, given that it's only what, a couple hundred kilometres or there about, whether there's a potential for some coordination.

Dr David Close: We had high level conversations. If we were to be moving towards projects where that requires a solution I think it would make sense. I think the industry has moved a long way from 2010, 2012 time. We'd look at ways to minimise waste impact, optimise the cost of the proponents plus make it more efficient and less impactful …… I think you're right that there's considerations around having fair contracts and having people being able to work, not creating ….. effectively. We will work through that to try and come up with a sense of a sensible solution. Anything you want to add?

Alexander Cote: I thought I'd just say that you also have to balance other items out. The additional pipelines that would be required or trucking to move things to central facilities versus individual facilities. Probably depend on exactly what that treatment scenario might look like.

Hon. Justice Rachel Pepper: I know there are a few more questions. Are you content to stay and answer them? I'm just worried about … we would but I'm also conscious that there may be forms of transport that can't wait.

Stephanie Stonier: We have maybe 15 minutes.

Hon. Justice Rachel Pepper: That's perfect, excellent. Dr. Beck.

Dr Vaughan Beck AM: Thank you very much. You've opened the gate. Couple of questions. We've heard repeatedly that Australia is awash with gas. The implication being that, why do this development. In at least one of the presentations at the hearing, information was extracted from a recent ….report to demonstrate that Australia is awash with gas. Can you enlighten us the panel as to what the situation is from your perspective so that we understand the details.

Dr David Close: Yeah I think it is a confusing subject matter area. We hear daily f, is there a supply crisis and others who would suggest that, as you say, we are awash with gas. Clearly the supply demand gap has tightened. I think that's no secret. If there was a readily available gas resource to expand quickly I think we would see that happening. If you look at this case …….there hasn't been any more resources rapidly being brought to market. I think that the answer lies in that free market. Over time you would expect the market to respond. There was always going to be a longer term transition as Australia became an exporter from the East Coast as well. We had decades of a relatively low, an efficiently low gas price that wasn't sustainable through necessarily the transition that was foreseeable.

I think there is definitely a place for Northern territory in the long term supply security in the East Coast. There aren't that many remaining large scale resources that could be added to the ….. in Australia over the coming decades that we know of today.

Dr Vaughan Beck AM: Will you be able to furnish us with some details? Origin and others are obviously looking at the potential development …..Others are telling us that we're awash with gas. As a panel, is conflicting messages coming and if you could help provide some documentation that would either reassure us or whatever, we'd be most grateful for that. As I said, one starting point was data that was extracted from a recent ….. report.

Dr David Close: Certainly come back with what might be origins of position as posted in retail or wholesale and generate and explore our own and give a position where we think that reflection on that.

Dr Vaughan Beck AM: That would be most helpful, thank you very much. Second question is, based upon that same ….. report, it said, it was reported to have said that the gas from the northern territory is going to be high priced gas at $7.50 at the ….. By the time that you add transport costs and so forth under that then intake gas will be blown out the water was the implication. Again, why are we going through this exercise?

Dr David Close: I think there's a range of outcomes that are all potentially in front of us. That could be that the Northern territory shower gas is not competitive with other sources of gas in the market. Whether it's North West …. coming through a network or whether it's marginal Queensland CSG players or expansion in the …. basins. I certainly don't know that answer. I think there are other possible range of distribution of outcomes in front and in the ……There are a suite of those where it could be marginally economic and there's a suite where it could be very economic.

Until we have further data to really understand what an individual well could deliver and what that individual well costs, that would either come the transport to cost differential if it was of sufficient quality. I think it's a really good question and we hope to get enough data to be able to put a great detailed case to you about what …….was. Look, I came to get funding for that project, you'd expect to be held to that level of thoroughness.

Dr Vaughan Beck AM: At what stage do you think you would be in a position to have that internal information to make a commercial decision?

Dr David Close: I think at the moment we'd hope if we were able to start doing further exploration and appraisal, you may if in a …….two to three years down that is clearly going to be successful. It could take three to five years if you're into that with the range down where the rate or return is less clear. I don't know that you again would know for sure what that time frame looks like. I think there's a report used to time frame about 10 years before you received ours. I think that's a reasonable starting point. We would support that kind of time range.

Dr Vaughan Beck AM: Making commercial decisions, it's going to be …….Another question is …

Hon. Justice Rachel Pepper: I think Dr. Ritchie also has a question as well.

Dr Vaughan Beck AM: You mentioned the analogue with ….. The test result from Amanji was I think initial flow of … I can't remember the figure.

Alexander Cote: Just over a million a day.

Dr Vaughan Beck AM: You could refresh my memory.

Dr David Close: A little bit over a million standing cubic feet a day.

Dr Vaughan Beck AM: A million standing cubic feet per day I think it was. This is now a question on speculation. The Marcella's field is current with delivering I think about four billion cubic feet. Clear there's a big range in that. Are you ready to speculate on the ……out of the ….. base and on the basis of you wanted?

Dr David Close: We do, we were quite cautious in ….release not to try and focus exactly what the….individual would be if it was a development well. That's quite sensitive information to give to our partners. I think we see the technical parameters …. assimilated players like the …. or …. such that the range of outcomes that they are able to achieve today would be if we are in a success outcome, a range that's not unreasonable for us to anticipate. A little bit round about ….. Bi analogue is our bet. With one data point, analogue is our best way. There's lots of ways if it was less than that. If you …. threshold it wouldn't be economic ….

Hon. Justice Rachel Pepper: Thank you. Dr. Ritchie.

Dr David Ritchie: Thank you. Given the time, could I ask that you provide us with a detailed explanation and just take us through the processes that you have engaged with the Northern lands council and the areas protection authority to assure that you have all the approvals in place and that your assertion to us today that you have consulted with all the actual owners of the land and native title holders or traditional owners in the form of if it's on ……land. That's another point that's been put to us that that hasn't taken place and I think that could be cleared up quite readily by advice. Thank you.

Stephanie Stonier: Dr. Ritchie by detailed explanation, will you be satisfied with us responding in writing with a data timeline of all our meetings and engagements and what the contents of those meetings were?

Dr David Ritchie: Yes, that would be, what do you call, the factual material that would accompany, an account at what you're actually doing in that. You're engaging for say the negotiation of an ….. you're entering a negotiation to get approvals under the …… Whatever you believe are the things you're doing to ensure that you have the approval of the traditional owners of the land.

Stephanie Stonier: We'll respond in writing. We can generally share with you that ….. we have and on country meeting. The intent of that on country meeting is to come back and report to traditional owners. Typically we have about 100 to 120 people at that meeting. The previous work out year's activities as well as discussing their consent on the activities to come. It's not the only meeting, there will be six, potentially eight meetings throughout the year with the Northern land council that are typically in relation to cultural heritage clearance work as well as confirming well locations. We go to traditional owners with the potential suite of well locations, there may be 16.

They'll immediately tell us that eight need to come out, two need to come out or all 16 are inappropriate and not allowed to be used. That's what we talk about by co design and co planning. Culture heritage surveys are done, NRC report. We then go to …..for certification before any activities take place. We will comprehensively detail the process for you for 2014, 15 and 16.

Dr David Ritchie: I'm assuming that you already have some approvals in Place as a result of that. It may just be of interest that the information that we got from …… from basically your applications for authority certificates, there were ….. vertical drill holes and well ….. They didn't actually mention at any stage that you're actually applying for a preliminary …… programme of hydraulic factory. In that sense the information you provided to the statutory authority, didn't include actually what you were proposing to do in the longer term. The same applies to everybody. Nobody did in your industry. It's just something perhaps you could address in your submission.

Hon. Justice Rachel Pepper: I am fielding requests from other panel members for more questions which I am in my capacity as chair declining. I take it that you won't be adverse to those other questions being put in writing and sent to you. Thank you very much. Thank you very much for giving up your time and coming and presenting again. We have taken more than was allocated. We're very grateful for your time and