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Santos

Hon Simon O'Brien MLC
Chairman
Standing Committee on Environment and Public Affairs
Western Australian Legislative Council
Parliament House
PERTH WA 6000

4 October 2013

Dear Chairman,

Parliamentary Inquiry into the Implications for Western Australia of Hydraulic Fracturing for Unconventional Gas

Santos welcomes the opportunity to provide the following submission to the 'Inquiry into the Implications for Western Australia of Hydraulic Fracturing for Unconventional Gas' by the Western Australian Legislative Council's Standing Committee on Environment and Public Affairs.

Who is Santos?

With its origins in the Cooper Basin in north-east South Australia and south-west Queensland, Santos is one of Australia's largest producers of gas to the domestic market and has the largest exploration and production acreage position in Australia of any company. Santos has developed major oil and liquids businesses in Australia and operates in all mainland Australian states and the Northern Territory.

Santos also has an exploration-led Asian portfolio, with a focus on three core countries: Indonesia, Vietnam and Papua New Guinea.

Santos has a significant oil and gas business in Western Australia (WA), which makes a major contribution to the company's earnings and production. Santos' oil operations in WA include the Santos-operated Mutineer Exeter and Fletcher Finucane facilities, as well as major interests in Stag, and the Barrow and Thevenard Island joint ventures. On the gas side of the business, Santos produces exclusively for the WA domestic market through its John Brookes, Spar and Reindeer fields using the company's processing capacity at Varanus Island and Devil Creek.

Santos is also an active explorer in offshore WA, with recent discoveries at Bianchi and Winchester in the Carnarvon Basin, and Crown and Bassett West in the Browse Basin.

All of the company's oil and gas in WA is sourced from offshore fields.

However, Santos and its joint venture partners discovered and developed the Cooper Basin oil and gas fields. This, combined with other onshore gas interests in

Queensland, New South Wales and the Northern Territory, arguably makes Santos Australia's leading onshore gas company.

In over 50 years of exploration and production, Santos has drilled over 2700 wells and currently produces from approximately 1300 oil and gas wells. To date, over 700 wells have been fracture stimulated in the Cooper Basin with over 1500 individual fracture stimulation stages having been pumped.

With over 3,000 employees across Australia and Asia, Santos' foundations are based on safe, sustainable operations and working in partnership with host communities, governments, business partners and shareholders

The role of natural gas

Natural gas is the fuel that will grow Australia's economy, contribute to the nation's energy security and meet the future energy demands of the energy-hungry Asian region. Natural gas is the primary fuel source for WA with more than half of WA's energy consumption derived from gas. The Australian Bureau of Resources and Energy Economics (BREE) forecasts WA gas consumption will continue to grow at approximately 2.2% per annum from 1,777 PJ in 2012-2013 to 4,036 PJ in 2049-2050 (See The Independent Market Operator 'Gas Statement of Opportunities', July 2013). Accordingly, the supply of natural gas is vital to the operation of the State economy.

The upstream natural gas industry is also a major employer in WA, and generates billions of dollars in taxes and export income each year.

Sources of natural gas

Natural gas is found in sedimentary basins, in a number of geological settings and within various rock types. All natural gas, whether it is described as conventional or unconventional, is composed predominantly of methane (CH4), with varying, usually minor, quantities of other hydrocarbons. The descriptor of conventional versus unconventional refers to the rocks or formations that the gas is trapped in and the methods required to extract it commercially.

Conventional gas

Conventional gas is trapped in porous and permeable reservoir rocks, such as sandstones, in favourable geological structures or traps, and within sedimentary basins. To date, most of the gas that has been produced, globally and in Australia, has been conventional gas. Conventional gas will flow at economic rates from wells drilled into the gas bearing formations.

Unconventional Gas

Unconventional gas is found in reservoirs that require specialised extraction technology such as dewatering or fracture stimulation to extract the gas from the formation at economic rates

1. Coal-seam gas (CSG)

CSG is natural gas that is extracted from coal. The gas is trapped in the natural fractures or cleats of the coal and also by adsorption onto the organic matter within the coal matrix. To enable the gas to flow, the coal seam needs to be de-pressured (to allow the gas to desorb) by dewatering the coal. Some coals are low permeability and in order to obtain economic flow rates of gas this permeability has to be enhanced by hydraulic fracture stimulation. However, Santos hydraulic fracture stimulates less than 10% of its CSG wells. CSG is produced in many parts of the world, and has been extracted in Queensland for the past 20 years.

2. Tight gas
Tight gas is not dissimilar to conventional gas, in terms of geological setting, except that the reservoir rock has a low permeability, meaning that it is more difficult to extract the gas than is the case for conventional, higher permeability sands. To extract the gas economically, the permeability has to be enhanced through hydraulic fracture stimulation. Tight gas has been produced in Australia in the Cooper Basin for some decades through the use of hydraulic fracture stimulation.

3. Shale
Shale gas occurs in very fine-grained, low permeability organic-rich sediments usually in deeper parts of basins. It is therefore necessary to enhance permeability to allow the gas to flow from the rock. This is typically done by combination of horizontal wells (wells with long horizontal or lateral sections giving them greater contact with the reservoir rock) and hydraulically fracture stimulation

Shale and tight gas resources are typically between two and four kilometres below the ground and separated from near-surface freshwater aquifers by at least a kilometre of impermeable rock.

What is hydraulic fracturing?

Hydraulic fracturing has been a commercial process in the oil and gas industry since 1947 and the Society of Petroleum Engineers (SPE) estimates that over 2.5 million hydraulic fracture stimulation treatments have been undertaken in oil and gas wells worldwide, with over 1 million in the United States. Hydraulic fracturing has been successfully used on wells in the Cooper Basin for nearly 50 years without incident and is currently performed in many Basins around Australia.

Hydraulic fracturing is employed where gas or oil is tightly held in low permeability reservoir sands, coals and shales to enhance the permeability of the formation and to enable the gas to flow at economic rates.

Hydraulic fracturing is not an explosive or high impact process. It is not part of the drilling process but is a completion technique applied after the well is drilled and the drill rig has moved to another well. Prior to the rig moving off, the well has been sealed with steel casing and cement. During the completion process, the casing is perforated and the well is stimulated via hydraulic fracturing. It is a process that results in the creation of small fractures in the rock to allow the oil and gas in the source rock to move more freely into the wellbore and enable economic hydrocarbon production. It involves pumping water, a specific blend of chemicals and proppants such as sand or ceramic beads down a well at sufficient pressure to create fractures in the low-permeability rock. The proppant material keeps the fractures open once the pump pressure is released and improves the production of the well.

Water accounts for about 90% of the fracturing mixture and sand accounts for about 9.5%. Chemicals account for the remaining 0.5% of the mixture and assist in carrying and dispersing the sand in the low-permeability rock. The chemicals are used for different functions and are not specific to hydraulic fracturing and have many common uses such as in swimming pools, toothpaste, baked goods, ice cream, food additives, detergents, cosmetics and soap. The chemicals are used to augment the following functions:

1. Viscosity – Gelling agents are added to the water to provide viscosity to enable the proppant material such as sand or ceramic beads to be transported down the well and into the created fractures
2. Friction Reduction – to reduce the force required to pump the fluid, friction reducers are added, making the fluid more "slippery" and easier to pump at the high pressures and rates required to create the fracture network.
3. Biocide – biocides or disinfectants are added to ensure that no microbes or organisms present in the water will destroy the gelling agents and also to ensure they will not enter and contaminate the reservoir
4. Scale and corrosion – scale and corrosion inhibitors are added to prevent deposition of mineral scales and to prevent corrosion of the steel casing or tubing.
5. Surface tension – surfactants or surface tension modifiers are added to assist the back flow of fluids from the formation

As part of the process, the sand or proppant material remains in the low-permeability rock while much of the fracturing liquid is recovered to surface prior to hydrocarbons flowing into the well.

Santos has decades of experience using this technology in the Cooper Basin in both South Australia and south-west Queensland.

The design and quality of the well construction is of paramount importance in managing, and avoiding, any environmental risks associated with hydraulic fracturing. Santos applies best practice in its drilling techniques and related activities.

Drilling and well construction
Well drilling is the process of drilling a hole in the ground for the purpose of extracting gas or oil. Drilling and completing a well or "well construction" consists of several activities as listed below, some of which are conducted several times;

- Building the well pad
- Setting up the drilling rig
- Drilling the hole to required depth
- Running formation evaluation logs to determine what the formation is and what fluids are contained within it
- Running the steel casing to line the wellbore
- Cementing the casing in place
- Removing the drill rig
- Logging the casing to ensure bonding of cement to the formation and casing and the top of the cement relative to formation depths
- Perforating the casing
- Stimulating the well if required
- Installing production tubing and surface equipment
- Production of oil or gas from the well
- Monitoring well performance and well integrity
- Reclaiming parts of the well pad no longer needed

Design and construction of wells is a critical process that needs to be both well regulated and well managed to ensure that groundwater and aquifer formations are protected and so the hydrocarbons can be produced safely throughout the life of the well.

Choosing where to drill

The level of impact of oil and gas production including hydraulic fracturing is strongly dependent on the location of the particular well – the rock structure, the location of faults and aquifers, and the proximity to those who may be affected. Subsurface geology will have a major influence in determining where a well is drilled but strong consideration is also given to surface issues such as populated areas, the natural environment, local ecology as well as existing infrastructure and access roads, water availability and disposal options. Sensitivity to these factors at this stage of development can minimise the impact of the activity on current and future land use.

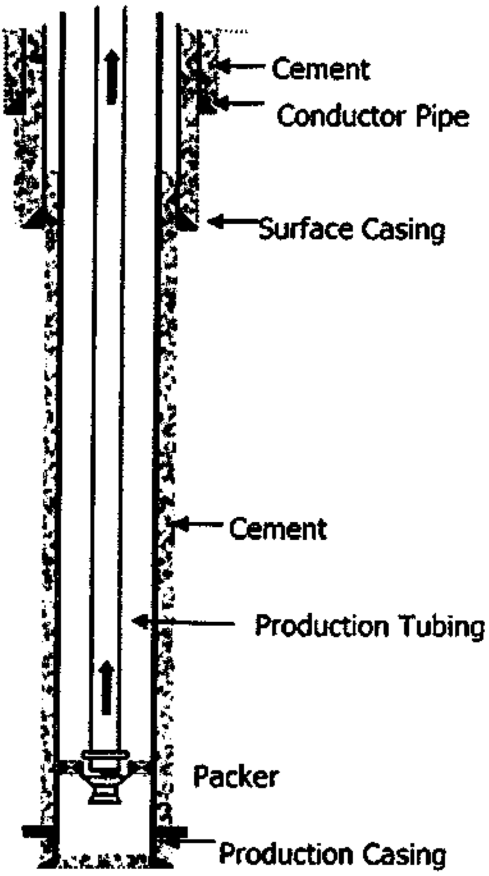
Establishing a well site

The first stage of developing any oil and gas well is to prepare the site. Santos engages in thorough discussions with the key stakeholders of the land before a site is located to ensure the concerns/activities of these stakeholders are considered. Site construction typically involves levelling of the site, if required lining of the site to minimise or prevent surface erosion, excavation of fenced pits with special impervious liners to hold drilling fluids and cuttings, and access roads for the transportation of equipment and materials to and from the site.

Drilling, casing and cementing

Drilling can take a few days or many weeks, depending on the geology, depth of the well, and whether the well is vertical or directional. As the hole is drilled, multiple layers of steel casing are inserted and cemented into place, providing a barrier between the contents of the well and the surrounding rock (see diagram below). Cement is forced down the inside of the casing and back up between the wall of the drill hole and the casing exterior, fixing it in place and sealing the gap. Cemented casing strings protect and isolate groundwater resources and aquifers from the oil or gas. The design and selection of the casing is important to ensure it is able to retain its integrity throughout the life of the well and withstand the forces it will be subject to from natural formation pressure as well as those from well completion, fracture stimulation and production operations. Wells may have from 2 to 5 casing strings that extend to different depths depending on individual well design requirements and conditions encountered. Understanding the depths of groundwater and useable aquifers is critical in the casing design of wells so that these resources are protected.

The construction aspect that is most important for well integrity is the correct composition, volume and placement of cement. The aim is to ensure that the cement binds tightly to both the steel casing and the rock, and leaves no cavities through which liquids and gases could travel. The cement serves two purposes – it provides protection and structural support to the casing while also providing zonal isolation between different formations, including groundwater and aquifers. At each casing stage the integrity of the well is tested to ensure that the steel casing and cement is able to perform the above purposes.



Establishing and maintaining the integrity of the well is critical to minimising the impact of hydraulic fracturing and future production operations on current and future land use. Wells are integrity-tested throughout their life. Santos has in place integrity management plans for all of its wells. These plans determine, based upon risk assessment, the frequency of the required well integrity testing. All wells are visited regularly for visual checks and casing annulus pressure readings and the individual well's risk rating is reviewed annually.

Hydraulic fracturing the well

When the cement and steel casing are in place and their integrity verified by both pressure testing and electric logs such as a cement bond log to validate the height and competency of the cement, the well completion process can begin. This is the final step to producing the oil or gas.

First, a perforating gun which contains a series of small specially designed shaped charges is lowered to the desired depth in the well and activated. These shaped charges create the holes through the casing and cement that connect the inside of the production casing with the geological formation containing the hydrocarbons. The producing zone is isolated both above and below by cement ensuring that hydrocarbons are unable to migrate anywhere except through the perforations and into the wellbore. Then the fracturing fluid is injected under high pressure and is forced through the casing perforations and into the rock, creating fractures.

The sheer weight of the overlying rock ("overburden") naturally limits fracture growth. Cracks are a few millimetres wide, about 30 metres high and extend anywhere from tens of metres to a few hundred metres from the well. The fractures will also vary in length due to the existence of natural faults, joints, or changes in rock type – these can either provide natural stopping points for a fracture or extend its reach.

Potential water Impacts
Hydraulic fracturing could impact water quality in three ways. These are from:

- Spills and leaks at surface – of chemicals, waste, or oil and gas during transport, storage, and use. These risks are relatively easy to manage through good practice, response procedures, and personnel training.

- Migration – where oil and gas or other fluids travel up through cracks in the rock (either natural fractures or those caused by stimulation) and eventually reach aquifers. Migration of chemicals into aquifers through the cracks created during the hydraulic fracturing process is only a remote possibility. This is due to both the presence of cement above and below the hydrocarbon-bearing formation at the wellbore. The likelihood of hydraulic fracturing creating vertical pathways into aquifers is further reduced if there is an impermeable layer of rock (cap rock) above the hydrocarbon zone that will limit fracture growth and prevent migration. Gas in shale is unable to freely migrate due to the impermeability of the shale itself unless under large applied drawdowns such as those from production, in which case the migration is only toward the wellbore. Another important factor in limiting migration is the depth of hydraulic fracturing below the ground and aquifers. In tight sands and shale, the distance between the depth where hydraulic fracturing occurs and the depth of aquifers is typically large – anywhere between a thousand to many thousand metres. Extensive micro-seismic mapping of thousands of hydraulic fracture stimulation operations has taken place in North America and show that the height growth of the created fractures is limited to a few hundred meters with even the largest fracture treatments.

- Mechanical failure of the well – where the well is designed or constructed incorrectly. Wells can leak due to poor design or construction. Properly executed hydraulic fracturing in a properly constructed well does not lead to groundwater contamination.

  Most gas wells can be expected to drill through aquifers ranging from freshwater to saline and at depths ranging from very near surface (tens of metres) to deep (hundreds to thousands of metres), and are subject to well integrity regulation. In the Cooper-Eromanga Basin, in addition to surface aquifers, gas wells (whether they are seeking conventional, tight or shale gas) pass through deep aquifers of the Great Artesian Basin. To minimise the risk to this vital groundwater resource, Santos ensures that producing wells are constructed to industry best practice and meet or exceed Government regulations which stipulate which formations need to be isolated from each other to prevent cross flow and contamination. Prior to hydraulic fracturing, Santos models expected well pressures for all fluids to be pumped into the well. During the hydraulic fracturing process, Santos monitors, in real time, various well data onsite and will immediately shut down a job if a pressure signature does not match the modelled pressures.

  In order to ensure that groundwater is protected, Santos applies a number of best practices relating to shale gas production and water management before, during and after drilling and hydraulic fracturing take place:

- Prior to hydraulic fracturing, all landholders' active groundwater bores (subject to access being permitted by the landholder) in any aquifer that is within 200 metres above or below the target gas producing formation and is spatially located within a two kilometre radius from the location of the stimulation initiation point will be tested before and after hydraulic fracturing to ensure there was no impact.

- A quality assurance program is put in place to ensure that the proper well-bore design and construction practices are followed. During the life of the well, integrity testing is performed regularly.

Waste Water Management

To get the well to flow gas, the flow back of residual fluid from the fracture stimulation operation must occur first. "Flowback" water is a mixture of the original hydraulic fracturing fluid and any natural formation water – containing dissolved constituents from the shale formation itself. The disposal of this wastewater and produced water has been the cause of some concerns. Flowback from hydraulic fracturing is managed in three main ways: it is re-used, treated in a local facility or disposed through injection in deep underground wells.

Underground injection is currently the primary disposal method for wastewater from most shale projects in North America. The wastewater is discharged into deep disposal wells that are subject to individual review and permitting.

However, there will be instances where the geology is not conducive to underground injection. Therefore, some wastewater is either treated on site or transported to local treatment facilities.

Wastewater may also be recycled and re-used for hydraulic fracturing, meaning there is less need for wastewater disposal and less use of local water sources.

Wastewater can be temporarily stored in pits, tanks or evaporation ponds.

At its Cooper Basin operations, Santos produces fracture stimulation flowback water into a combination of tanks and lined pits. This ensures that surface contamination cannot occur. The water is then treated for re-use or allowed to evaporate at approved facilities.

During the flowback period, gas that flows up the well can be vented into the air or lit and flared. It is preferred to flare the gas both for safety reasons and to minimise green-house gas emission intensity. Air pollution and greenhouse gas emissions can also be effectively reduced through the use of 'green completions' – a series of processes that separate the gas from the returned water more effectively than conventional processes and allow it to be captured rather than vented or flared. Santos currently flares flow back entrained gas and is working towards implementation of "green completion" operations to further minimise emissions. Green completions require infrastructure such as pipelines to be in place during completion operations and thus may not be possible during the exploration or appraisal phases.

Seismic activity

Although there is ample evidence in Australia of induced seismic activity associated with large dams, mining operations and geothermal operations, there is currently no seismic risk data for oil and gas-related activity in Australia, such as hydraulic fracturing operations. Overseas evidence suggests that induced seismicity of magnitude 3 to 4 can be generated by the reinjection of large volumes of produced water in deep wastewater wells or in geothermal operations, particularly at or near a critically-stressed fault, but hydraulic fracturing is unlikely to lead to damaging or felt seismic events. Overseas evidence from extensive shale gas operations documents only a few cases involving low magnitude seismic events, where the hydraulic fracturing process itself has resulted in induced seismicity. These few events have been linked to the intersection of active fault structures by hydraulic fractures. Best practice mitigation, which Santos employs, involves the identification and characterisation of local fault structures, avoidance of fracture stimulation in the vicinity of active faults, real-time monitoring and control of fracture growth through available sensing technologies and the establishment of 'cease-operation' triggers based on prescribed measured seismicity levels.

Term of Reference 1: How hydraulic fracturing may impact on current and future uses of land?

Santos' existing onshore operations, in eastern Australia, show that agriculture and natural gas extraction can coexist successfully. As the global population increases, sustainable and multiple uses of land is the best response to increased domestic, regional and global demand for food and energy. This is particularly true when both can be provided safely and sustainably from the same land.

The surface footprint of low-permeability rock oil and gas extraction is generally relatively small and temporary in nature. The exception to this is access roads and occasional infrastructure such as treatment and compressor stations, and centralised water treatment facilities. During their construction phase, wells are normally of an area of 1.5 ha or less for up to one year, and then decrease to approximately 25m by 25m, or 0.07ha for their productive life of approximately 20 to 30 years. At the end of their productive life, the wells are plugged with cement and rehabilitated, and surface facilities are removed, in accordance with Government approvals, guidelines and regulations, with effectively no surface impact remaining.

Santos understands that landholder access is one of the most important issues to address and get right on an ongoing basis as the gas industry grows. Clearly, landholders have legitimate concerns about how gas exploration and production will impact upon their existing land use, operations and property valuations. Creating respectful, mutually beneficial partnerships is a key priority for Santos. Every reasonable attempt is made to ensure that surface facilities are generally located in areas that are not visible from public roads, or homesteads, and away from the more intensively used areas of the property. Placement of wells, roads and infrastructure corridors are made in discussions with landholders so that impacts are minimised and if possible mutual benefits are realised.

Santos approaches landholders respectfully and in the spirit of a genuine negotiation, rather than with demands or a pre-determined outcome. Santos understands and acts to get the basics right by managing simple, but significant, issues such as closing property gates and preventing the spread of weeds.

Santos recognises that the impact its activities, including hydraulic fracturing, will have on the current and future use of the land depends significantly on the location of the particular well and the quality of its design and construction.

That said, it is also worth noting that the use of hydraulic fracturing may result in a smaller land-use footprint than via traditional onshore oil and gas operations as the use of hydraulic fracturing increases the economic drainage of the well resulting in less overall numbers of wells. Combined with the use of multi well pads where a number of wells are drilled directionally from a single pad further reduces the land use footprint. The U.S. Department of Energy (DOE) reports (see The International Gas Union 'Shale Gas: The Facts about the Environmental Concerns', June 2012) that just six to eight horizontal wells from one vertical location can access the same or greater shale reservoir volume as more than 16 conventional vertical wells – each requiring its own well pad, roads and pipelines.

In the Cooper Basin, multi-well pad development has resulted in a 55% reduction in surface disturbance compared to individual single well pads.

By applying best practice construction of surface and subsurface infrastructure, and by working with all stakeholders, the impact on current and future uses of land is not impacted by the use of hydraulic fracturing.

Term of Reference 2: The regulation of chemicals used in the hydraulic fracturing process

All fracturing fluids contain a small proportion of additives. These fulfil very specific purposes, such as controlling rust, reducing bacteria levels or to improve the overall productivity of the well. On average, chemical additives make up only 0.5% of hydraulic fracturing fluid and many are found in food additives, makeup and household cleaning products. The hydraulic fracturing fluid is controlled and does not come into contact with fresh water at any point in the hydraulic fracturing process due to the cement and casing surrounding the wells.

Santos is committed to keeping people well informed about our activities and supports the public disclosure of the additives (including maximum component concentrations) of the additives, such as fracfocus.org in the United States.

There are several geologic and reservoir characteristics, including mineralogy, permeability, pressure and temperature, that are considered in selecting an appropriate fracturing fluid. Service companies have developed a number of different hydraulic fracturing fluid recipes to more efficiently induce and maintain productive fractures. These solutions have unique characteristics and therefore the exact concentrations of some additives may be protected as proprietary information. Intellectual property rights are critical for businesses; these rights enable business to benefit from their investments and remain competitive in a global market place, allowing for continued innovation and hence improvement.

A potential unforeseen outcome of full disclosure, including constituent hydraulic fracturing fluid recipes, is that new, innovative and more environmentally benign products may not be used, with companies only having available older and less beneficial alternatives.

Term of Reference 3: The use of ground water in the hydraulic fracturing process and the potential for recycling of ground water

Water used during hydraulic fracturing is either taken from surface water sources (such as rivers, lakes or the sea) or from local boreholes (which will draw the water from shallow or deep aquifers) or from 'town' supply (trucked to site) pending availability and applicable regulations. Water may also be re-used from other sources, such as produced formation water from adjacent oil and gas production. Santos does this in the Cooper Basin to reduce the amount of bore water required. With advances in fluid chemistry, it is no longer required to use fresh, potable water for hydraulic stimulation.

Water is a key input for shale gas production. It can take up to about 11 million litres of water to hydraulically stimulate a well. This has raised concerns about depletion of local water supplies. But the amount of water used in shale oil and gas production needs to be viewed in context with other industrial, commercial and agricultural water uses. Typically, it is a fraction of the total usage for agricultural, industrial and recreational purposes.

Cumulative impacts assessment data was assembled by the New York City Department of Environmental Protection for the Impact Assessment of Natural Gas Production in the New York City Water Supply Watershed and showed that the volume of water required for a single hydraulic fracturing for the life of a major gas field (3,000 wells) is in the order of 45,600 ML (45.6 GL) which, while a large amount of water, is modest when set against consumption in irrigated agriculture (see The Australian Council of Learned Academies (ACOLA) report 'Engineering Energy: Unconventional Gas Production: A study of shale gas in Australia', May 2013).

Best practice is to minimise the amount of water used in the well construction and hydraulic fracturing operations, and to re-use produced water.

Term of Reference 4: The reclamation (rehabilitation) of land that has been hydraulically fractured.

When a well reaches the end of its productive life, it has to be shut down and abandoned. Akin with initial well construction, the abandoning of oil and gas wells needs to be well regulated and managed to ensure the required end outcomes are achieved.

At abandonment, companies remove as much equipment from the well as possible before plugging the well with a number of cement plugs. The placement and verification of the integrity of these plugs is a critical step to ensure that the remaining hydrocarbons cannot leak into overlying formations and cause contamination. Casing and cementing is cut off below the surface and removed so that land can be returned to other uses. In addition, the company will disassemble any remaining buildings, tanks, and other infrastructure and will restore the land to its former state. The end goal of any abandonment program is that there should be minimal evidence that oil and gas operations have taken place.

While the operating company has tenure over the land they are responsible for all activities and to ensure that wells have integrity and do not cause cross flow contamination. Post abandonment and the relinquishment of production licence area Government regulators need to be satisfied that the abandonment operations have been carried out to required best practices so that future contamination risks are minimised.

Conclusion

The process of hydraulic fracture stimulation is not new to WA and has been applied safely to more than 780 wells since 1958. Advancements in hydraulic fracture stimulation and drilling technologies over the past decade have made the application of these processes for the production of shale and tight gas economically viable.

Currently WA's shale and tight gas industry is in the early exploration and proof of concept phases, but a significant opportunity awaits the State due to its large shale and tight gas resources. WA is estimated to contain 280 trillion cubic feet of potential shale and tight gas resources. Of this, 235 trillion cubic feet is estimated to be in the Canning basin (Kimberley and East Pilbara regions) and 45 trillion cubic feet in the northern Perth basin (Mid West region). To put this resource into perspective, WA currently consumes approximately 0.5 trillion cubic feet of domestic natural gas each year for everyday requirements such as electricity, heating, transport, manufacturing and mineral processing. If the 'shale gale' that swept through the United States in recent years (turning the nation from a major importer of gas to imminently an exporter of gas) is any example, WA is well placed to enjoy the major energy security, tax and royalty, and employment benefits that will flow from the industry's development. From Santos' experience in the Cooper Basin, the use of hydraulic fracturing does not significantly impact on the use of land by others, nor does it lead to the contamination of water aquifers. The key to addressing concerns around the impact of hydraulic fracturing on land use (in the short and long term) and aquifers lies in proper engagement with key and local stakeholders, identifying the right drill location, the quality of well design and construction (well integrity) and the protocols around testing and auditing. Employing best practice in these areas has led to safe, environmentally sustainable and successful operations for Santos in the Cooper Basin.

Yours Sincerely,

Tom Baddeley
Manager – Government and Community Relations, WA&NT
Santos