



Shale and Tight Gas in Western Australia

**An overview of Western Australia's
guide to the regulatory framework**

August 2016

Contents

Foreword	1
Shale and tight gas in Western Australia	2
Statutory framework	4
Operational requirements	5
Community engagement	8
Addressing potential issues and impacts	9
Compliance and enforcement	10
Glossary of terms and abbreviations	11

Foreword

This overview is an abridged version of the 'Guide to the Regulatory Framework for Shale and Tight Gas in Western Australia - A Whole-of-Government Approach' which was published in 2015 by the Department of Mines and Petroleum in consultation with the Department of Health, Department of Water, Environmental Protection Authority, Office of the Environmental Protection Authority, Department of Aboriginal Affairs, Department of Environmental Regulation, Department of Parks and Wildlife, and Department of Planning.

A whole-of-government approach is a key element in the development of the State's mineral and petroleum resources. This means that public sector agencies work collaboratively across portfolios to achieve an integrated response to the development of these resources.

Western Australia's shale and tight gas resources represent a significant economic opportunity for the State and offer benefits to regional communities. The scale of these resources could have a transformative impact on the State's energy strategy and security into the future.

The Western Australian public expects that the agencies charged with assessing and regulating petroleum resources, including shale and tight gas projects, do so with caution, rigor and transparency.

The Government of Western Australia and its agencies are aware of this expectation as Western Australia seeks to maximise the benefits these developments can provide. To this end, Government works collaboratively and collectively to manage risk inherent to the industry under one regulatory framework.

Shale and tight gas in Western Australia

Shale is a type of sedimentary rock formed of very fine-grained, or small particles, such as clay, that have been compacted to form a layered rock. Clay has a high organic content derived from organic matter such as plant debris, which over time was degraded to become petroleum (oil and gas). Shale rocks were traditionally considered to be the source of the petroleum found in sandstone and carbonate rocks. This petroleum, under pressure, was squeezed out and migrated from the shale through pore spaces to become trapped in other rocks such as sandstones, however some remnant petroleum remained in the shale formation. This is known as shale gas and shale oil. Only recently in the US has this resource been developed. The rest of the world is starting to emulate this development.

Permeability refers to the interconnectivity in the pore spaces between the particles making up the rock (Figure 1). Where there is greater interconnectivity, the rock has high permeability. Where the connectivity is limited, the rock has low permeability. The pore spaces in these low permeability rocks are tiny and not well connected, so it is difficult for fluids such as water, oil or gas to move through the rock.

Tight gas refers to natural gas found in low permeability reservoir rocks that are most often sandstone, but also include low permeability carbonate rocks. Shale gas and tight gas are known as 'unconventional gas' because the gas may not flow freely into a petroleum well. Conventional oil and gas occurs as discrete reservoirs of petroleum in highly permeable carbonates or sandstones that are usually found trapped beneath layers of impermeable rock, such as those found in the offshore sedimentary basins of Western Australia's North West Shelf and many conventional gasfields in the northern Perth Basin.

In Western Australia, shale and tight gas rock formations are found between 2000 and 4000 metres below ground. These resources lie significantly below groundwater resources and under multiple thick layers of low permeability rock that act as barriers between the formation and any water resources, and the land surface.

Coal seam gas (CSG), which is sometimes known as coal bed methane, has not been demonstrated to be prospective in Western Australia and is unlikely to be so because of the different geology to Queensland and New South Wales.

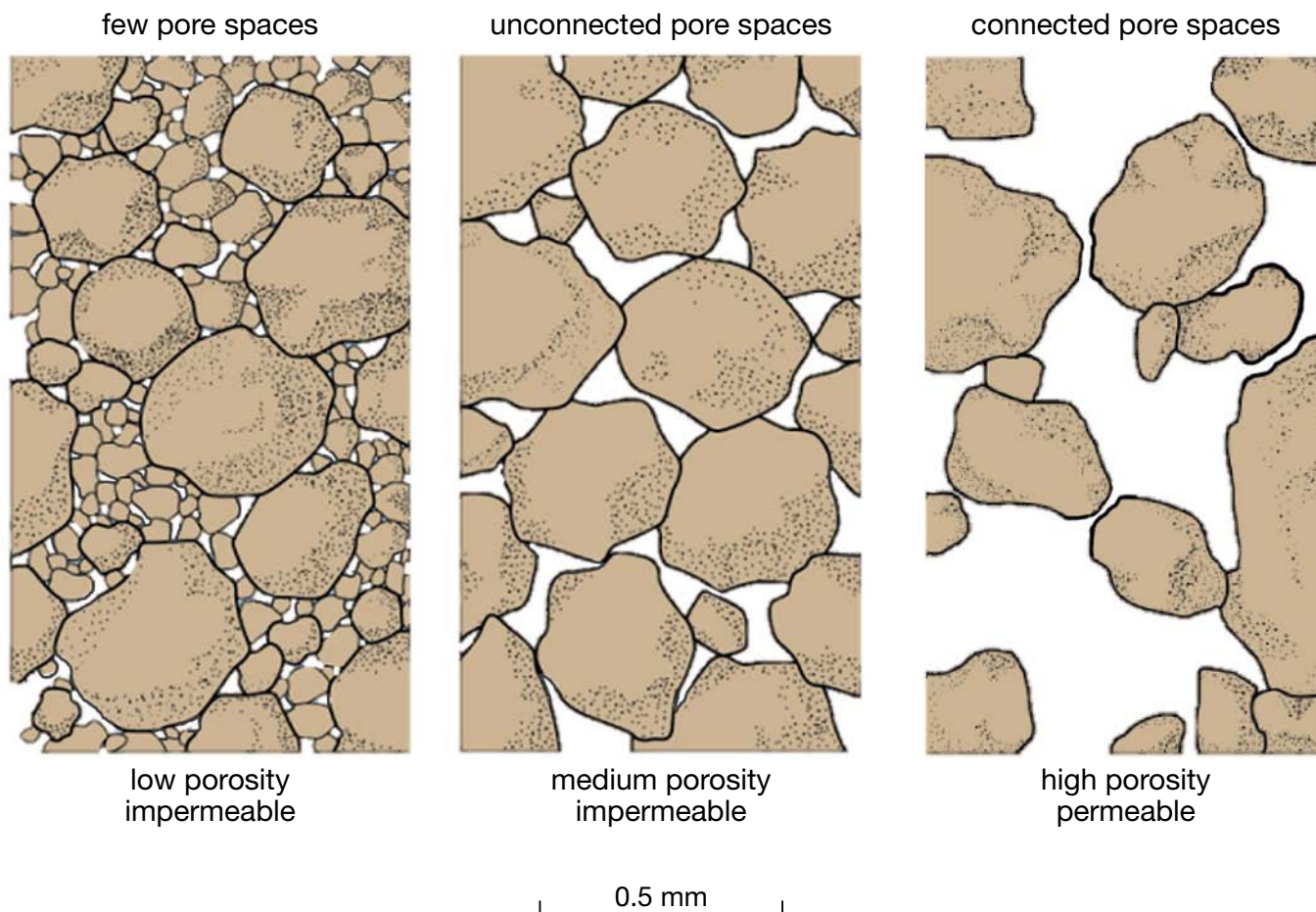


Figure 1: Schematic diagram of microscopic view of sandstones ranging from low porosity-impermeable rock to high porosity-permeable rock

Western Australia's Canning and Perth Basins have been identified as being potentially prospective for shale and tight gas. The Department of Mines and Petroleum (DMP) has estimated that Western Australia holds shale gas resources of approximately 37 000 billion cubic metres (Gm³), or 1300 trillion cubic feet (Tcf). Of this resource, DMP currently estimates that around 2600–5350 Gm³ (100–190 Tcf) could be produced, depending on how much of the resource can be recovered, given current knowledge of the geology of the area and future technological advances. To put this figure into perspective, 28 Gm³ (which is equivalent to 1 Tcf) is enough energy to supply a city of one million people with electricity for 20 years. Western Australia currently produces around this amount per year, mostly from conventional gasfields offshore.

Figure 2 shows the locations of the sedimentary basins that have potential to host shale gas resources in Western Australia.

A number of tight gasfields have been discovered in the Canning and Perth Basins. Tight gas resources have not yet been estimated for the State as a whole because tight gas locations cannot be as easily defined as prospective shale gas formations.

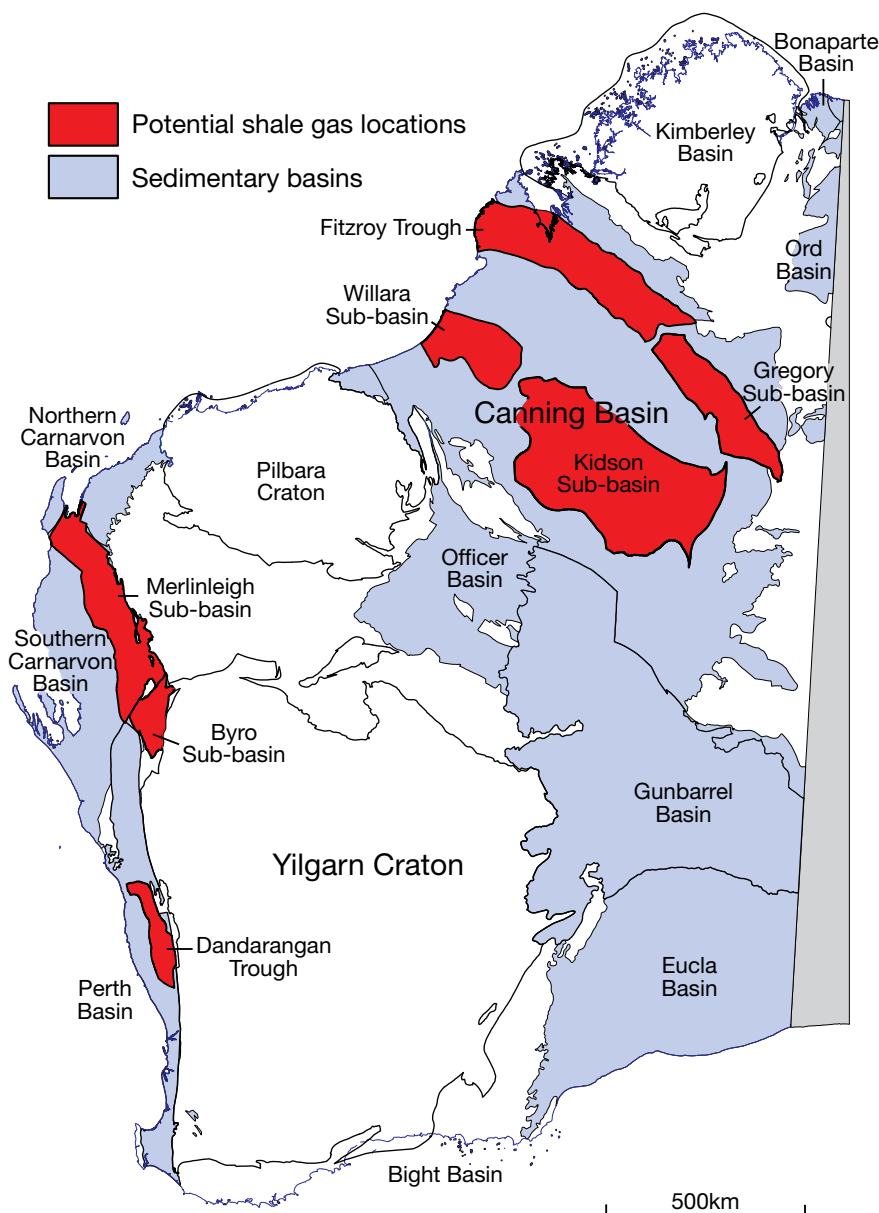


Figure 2: Sedimentary basins of Western Australia showing potential shale gas resource locations

The first stage of developing a shale or tight gas resource is to explore for the resource. The exploration stage to identify a resource can take up to five years. The proof of concept stage involves drilling multiple wells to determine the physical extent, reserves, and likely production rate of the resource, and may take five years or more. If a discovery is commercially viable, a shale or tight gas project could be in production for as many as 40 years.

Construction of pipelines and other infrastructure is a necessary part of the development. Developments in the Perth Basin will be able to take some advantage of existing infrastructure. This feature is likely to improve the economic viability of relatively small gas discoveries and reduce the timeframe required for these discoveries to reach production and contribute to the domestic gas supply.

In contrast, the remoteness and lack of existing infrastructure in the Canning Basin poses increased challenges to petroleum explorers in this area. Development of small gas discoveries may not be economically viable in the short term.

Statutory framework

The Western Australian Government has been regulating the oil and gas industry for nearly a hundred years. The regulation by government covering the development of a petroleum resource — irrespective of whether it is for conventional petroleum, shale gas or tight gas — is exactly the same. All future projects will be assessed on a site-by-site, project-by-project basis with regards to safety and the environment.

The regulatory framework rests on five key principles:

1. Transparent, effective and risk-based regulation
2. Whole-of-government approach
3. Consistent State and Commonwealth Government objectives
4. Effective engagement with stakeholders, particularly local communities
5. Compliance and enforcement

DMP is the lead agency responsible for the regulation of petroleum activities in Western Australia. The key statutes, administered by DMP relating to shale and tight gas, are the *Petroleum and Geothermal Energy Resources Act 1967*, the *Petroleum (Submerged Lands) Act 1982* and the *Petroleum Pipelines Act 1969* and associated regulations.

DMP's lead agency role is complemented by key regulatory processes undertaken by the Department of Water, as well as the Environmental Protection Authority (EPA) and Office of the Environmental Protection Authority (OEPA).

Other State Government agencies, including the Departments of Environment Regulation (DER), Parks and Wildlife (DPaW), Aboriginal Affairs (DAA), Health (DoH), Planning (DoP), and the Radiological Council support these major regulatory agencies.

These agencies regulate and approve a variety of elements with respect to shale and tight gas developments (along with all other oil and gas developments in State jurisdiction) under legislative powers relevant to each agency. These agencies' roles include conducting detailed environmental impact assessments where activities may result in significant environmental impacts, providing licences to extract water, the protection of drinking water, and protecting Aboriginal heritage.

Commonwealth legislation also regulates the development of shale and tight gas projects. The *Environment Protection and Biodiversity Conservation Act 1999* applies where a proposed exploration or development action is likely to have a significant impact on a matter of national environmental significance.

Beyond the environmental approvals and reporting requirements required under the petroleum Acts and regulations (administered by DMP), additional environmental assessments may be required in some cases before approval is granted. Depending on the nature of the potential environmental impact, this can result in additional environmental assessments and approvals being required from the State Government's Environmental Protection Authority or the Commonwealth Government's Department of the Environment (DoE).

EPA is an independent statutory authority established under the provisions of the *Environmental Protection Act 1986*. One of EPA's primary roles is to assess the environmental impacts of proposals that may have a significant impact on the environment. EPA then makes recommendations to the Minister for Environment, who decides whether to approve the proposal. Approval may be subject to conditions. Compliance with conditions of approval is monitored by the Office of the Environmental Protection Authority (OEPA).

The Australian Government, through DoE, is required to assess any action that has the potential to have a significant impact on a matter of national environmental significance. Matters of national environmental significance are defined under the *Environment Protection and Biodiversity Conservation Act 1999* including:

- World Heritage properties
- National Heritage places
- wetlands of international importance (Ramsar wetlands)
- listed threatened species or ecological communities
- migratory species protected under international agreements
- the environment where nuclear actions are involved (including uranium mines)
- a water resource

While DMP is the primary regulator for petroleum activities, it works in conjunction with other agencies in accordance with formal arrangements. These arrangements are as follows:

- Administrative agreement between the former Department of Environment and Conservation and DMP

- Consultation with the Department of Parks and Wildlife
- Agreement with the Department of Health
- Memorandum of Understanding with the Radiological Council
- Agreement with the Department of Water
- Memorandum of Understanding with the Department of Aboriginal Affairs
- Memorandum of Understanding with the Western Australian Planning Commission and the Department of Planning

In order to explore for any petroleum resource, a company must apply for, and be granted, a petroleum exploration title over the relevant area of land, whether it be Crown land or private land. An exploration title can be granted after successful finalisation of native title access arrangements. Once DMP grants a petroleum title, the registered holder(s) may agree to provide compensation to the landowner for the right to occupy private land. The registered holder must pay compensation to the landholder or neighbouring land users for loss or damage incurred, as follows:

- damage to the land including damage to improvements or rights of way, and all consequential damage
- the landholder being deprived of possession or use of the land
- severance (separation) of adjacent land owned by the landholder.

DMP evaluates all technical matters relating to drilling for petroleum, formation evaluation, resource management and production in accordance with industry best practice. Before any activity commences, DMP must have approved the operational (well and field), safety and environmental management plans for the project. DMP will monitor progress of the project through submitted reports, and undertake inspections to determine compliance of the approval conditions. Enforcement action may be undertaken where non-compliance is identified.

If a discovery is commercially viable and a location has been declared, the operator may apply for a Production Licence. Prior to the grant of the Production Licence the applicant will need to comply with the requirements of the Commonwealth *Native Title Act 1993*. Once native title agreement is reached, the grant of a Production Licence can proceed. Prior to project development, access arrangements with landholders must be settled.

At the end of the project's life, the petroleum field is decommissioned, where the wellhead, pipelines and other surface facilities are removed and the land is rehabilitated to its pre-existing state, in consultation with the landholder. Decommissioning may also occur where exploration activities have been unsuccessful. To decommission a well, the production zone is isolated with cement and barriers placed within the casing so that no fluids can flow into or out of the well once the wellhead is removed.

Operational requirements

The operational standards that apply to shale and tight gas projects are subject to the provisions of all State and Commonwealth legislation relevant to the activity. There are many Australian and international standards that are applied throughout the approvals process, which build upon the requirements provided in the regulations and legislation. These standards assist operators in carrying out risk assessments reported in the environment plans, safety management systems/safety cases, well management plans and field management plans required by DMP.

Of particular relevance to shale and tight gas is the American Petroleum Institute (API) standards program accredited by the American National Standards Institute. API publishes standards for the petroleum industry. These standards take into consideration the experience and new technology from the large number of wells that have been constructed and operate in the US. DMP refers to such standards when assessing operational plans.

Oil and gas producing wells are constructed with multiple barriers to isolate produced well fluids from subsurface rock formations and the external environment. Barriers in well design comprise cemented steel casing, tubing, seals and valves, all of which are pressure rated and tested. These components are specifically designed for the subsurface conditions of each well.

The main aboveground barrier of petroleum well is an assembly of valves and fittings that control the flow of oil or gas and is known as a 'Christmas tree' (Figure 3). The Christmas tree sits on top of the wellhead and it is the interface between the well and a production facility. It allows for surface monitoring and control of production of petroleum from a well.

Established standards for well integrity include the principle of having at least two barriers between the subsurface environment and the interior of the well (Figure 3). Effective well design prevents petroleum loss into the subsurface or aboveground environment, while also preventing water and other material entering the well. This objective is achieved by cementing protective, pressure-rated, steel casings between the well bore and the surrounding rock formation. This well design also protects groundwater from contamination.

A number of international studies have been completed examining well failure and well failure rates. Well barrier failure and well failure to the environment are not the same. A properly constructed and designed oil and gas well will have multiple independent barriers providing well integrity. A well may have an internal barrier failure without resulting in hydrocarbons escaping to the environment. Continuous monitoring of well activity will indicate when a well barrier is about to fail or fails so that action can be taken immediately to correct the problem. All failures, including very minor leaks, must be fixed and reported to DMP.

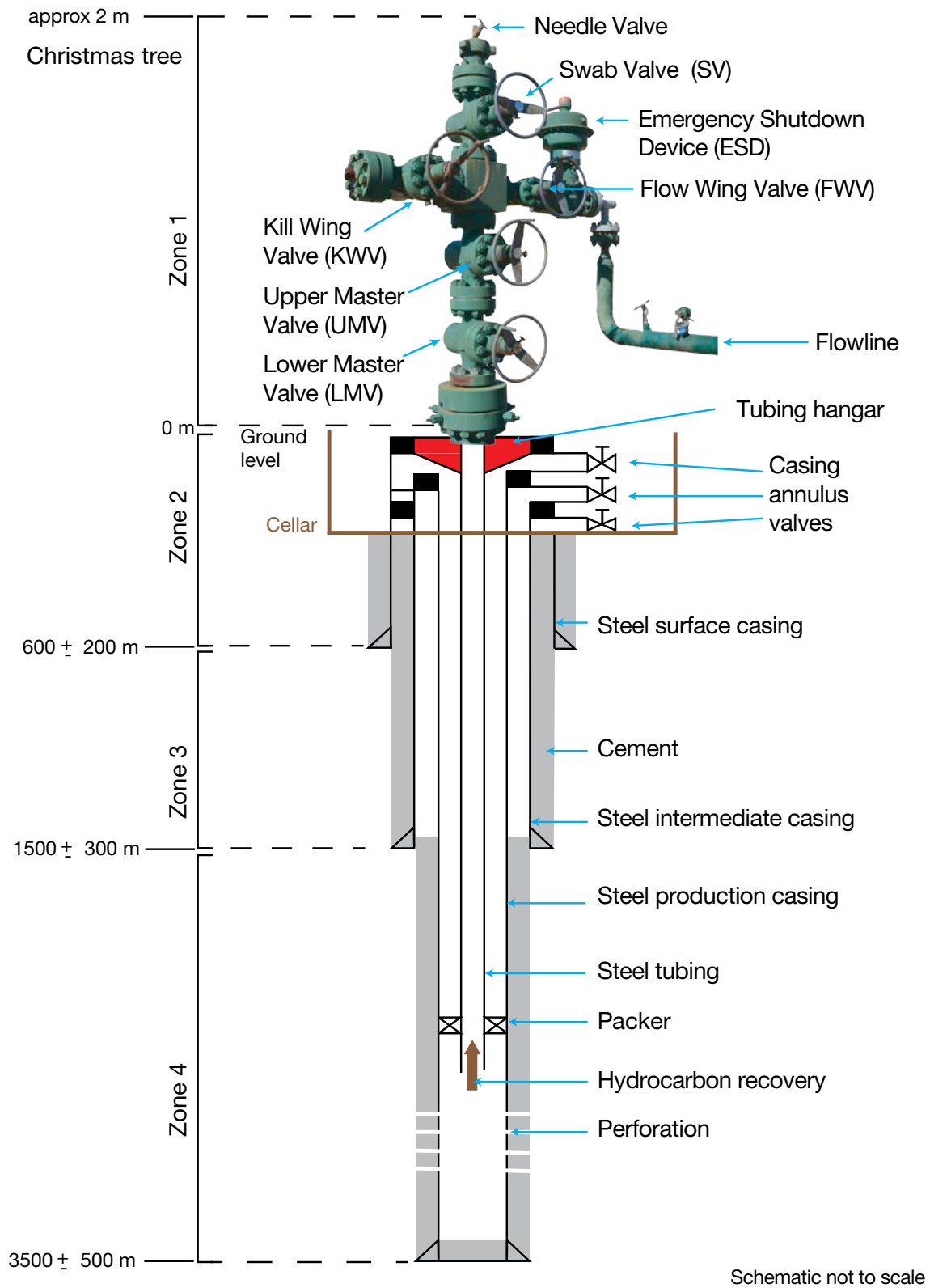


Figure 3: Photograph of a 'Christmas tree', which is the part of an oil or gas production well above ground, sitting on an illustration showing the well barriers (casing and cement) below ground in cross section (not to scale)

Hydraulic fracture stimulation is a technique that has been applied in the oil and gas industry for nearly 70 years. It was originally developed to assist in extracting a greater amount of oil and gas from conventional reservoirs. Now this technique is used to develop shale and tight gas resources.

Hydraulic fracture stimulation involves pumping fluids and 'proppants' (solid material such as fine sand grains or ceramic beads) into a low-permeability rock under high pressure to induce fractures. Typically the fluid is about 90 per cent water with 9.5 per cent proppant and 0.5 per cent chemical additives. Additives are used to suspend the proppant in the fluid, stop algal growth, prevent corrosion and make it easier for the fluid to move through the fractures. When the pumps are turned off, the proppant contained in the fluid remains in place, holding the fractures open and allowing the excess hydraulic fluids and the gas to flow out of the shale and up the wellbore (Figure 4). Forty to seventy per cent of the fluid can be recovered and reused in further hydraulic fracture stimulation programs.

Water is typically required to drill a petroleum well, but the amount of water used for a shale or tight gas project is greater than in a conventional well, due to the hydraulic fracture stimulation process.

Based on overseas and domestic stimulation activities, DMP estimates that the following volumes of water would be required to drill and hydraulically fracture a rock formation:

- a vertical well with three fracture stages averages 7 million litres of water per well, equivalent to 2.8 Olympic size swimming pools:
 - 1 million litres for drilling
 - 6 million litres for hydraulic fracture stimulation.
- a horizontal well (with a horizontal length of 1 km) with ten fracture stages averages 21 million litres of water per well, equivalent to 8.4 Olympic size swimming pools:
 - 1 million litres for drilling
 - 20 million litres for hydraulic fracture stimulation.

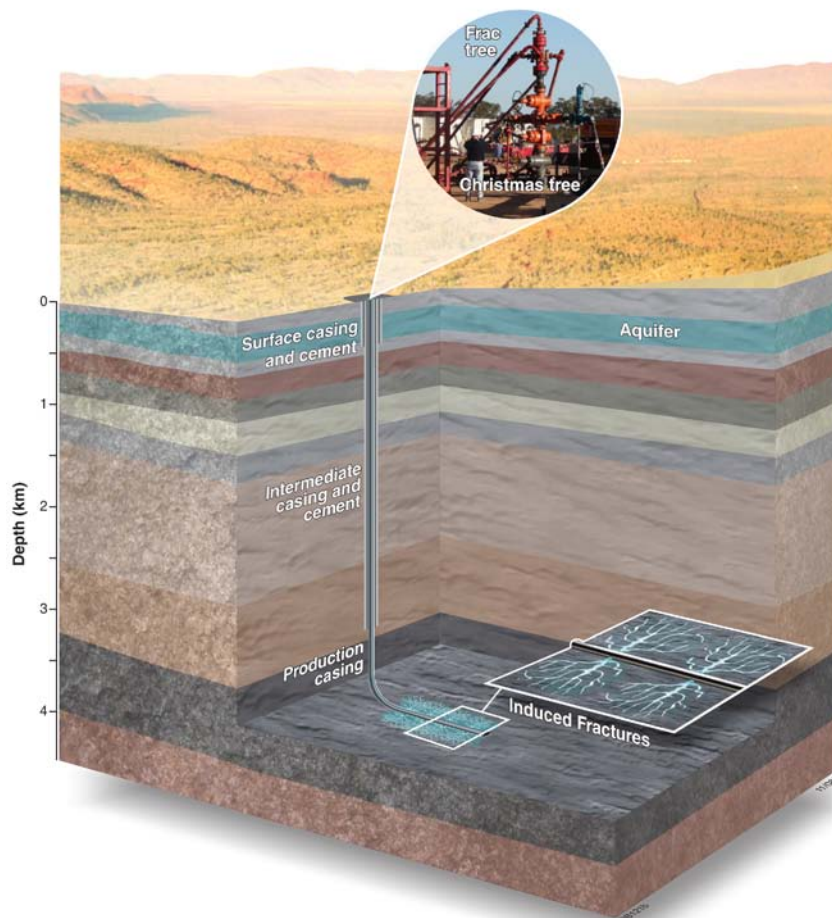


Figure 4: Schematic diagram showing a horizontal well intersecting a shale formation, in a typical Western Australian setting. At the surface, hydraulic fracture stimulation equipment (including the frac tree) is attached to the Christmas tree on top of the well. The image is cut away to show what the subsurface and well path would look like. The horizontal section has undergone hydraulic fracture stimulation. Lower inset shows induced fractures in the shale formation.

Comparisons with agriculture and household water use can put these amounts of water in perspective. For example, DoW estimates that each year in Western Australia:

- 750 000 million litres of water are used for agriculture;
- the average horticultural farm (about 1200 hectares in size) uses 20 000 million litres for irrigation;
- the average sized household uses about 530 000 litres of water.

In Western Australia, most water for petroleum activities is sourced from underground aquifers relatively close to the surface. Non-potable water can be used for hydraulic fracture stimulation, including water with salinity equivalent to seawater.

Access to water is regulated by DoW and the specific regulatory requirements are in the *Rights in Water and Irrigation Act 1914*.

Licences to take water specify the maximum allowable volume of water to be taken over a 12-month period. They are generally issued for 10 years, though this period can vary depending on circumstances. Conditions can be imposed on the licence to manage water quality and quantity and require licensee monitoring, reporting and metering.

DMP will not approve a chemical's use where it presents an unacceptable risk to the environment, water resources and/or public health.

The Petroleum and Geothermal Energy Resources (Environment) Regulations 2012 (environment regulations) require the disclosure of chemicals and substances used for 'down-hole' petroleum activities. This means the environment plan must detail all chemicals and other substances in, or added to, drilling or treatment fluids or introduced into a well, reservoir or subsurface rock formation during an activity. This includes drilling, cementing or hydraulic fracture stimulation during exploration, proof of concept, production and well decommissioning. This information is made publically available in the 'Environment Plan Summary' on the DMP website.

Chemical disclosure information provided to DMP includes information about all the chemicals being used, including relative toxicity to humans and the environment, biodegradation and bioaccumulation information and the volume and concentration of chemicals in the fluid. As a matter of best practice, DMP advocates the use of less hazardous chemicals where available.

An environment plan must provide details about measures undertaken by operators to reduce the risk of a spill occurring during their activities.

The environment regulations require a spill contingency plan to be included in an environment plan for all activities. It should cover all potential spill sources and risks, including chemicals, drilling fluids, fuels and other substances.

The disposal of waste must be detailed in an operator's environment plan, which is subject to DMP's approval. DER also regulates the transportation of controlled waste on roads under the Environmental Protection (Controlled Waste) Regulations 2004.

Wastewater from the process of hydraulic fracture stimulation is regulated primarily through DMP and by DER where it is associated with a prescribed premises licensed under the *Environmental Protection Act 1986*. It may be disposed of through:

- Evaporation ponds – These are open ponds lined with strong plastic used to hold flowback fluids or produced formation water. As the water evaporates, fine solids and chemicals remain in the pond. At the end of the evaporation process, the dried contents of the ponds are tested for contaminants.
- Injection/re-injection – This process involves disposing the wastewater underground by injecting into deep porous rock formations.

Community engagement

Community engagement refers to the interactions between government, industry, the public and communities to enable more informed and better planned policies, programs, projects and services. These interactions cover a wide variety of government–industry–community engagements ranging from information sharing to community consultation, which can be formal or informal. Effective engagement builds confidence with stakeholders, including the community.

The laws and regulations governing petroleum projects in Western Australia impose a number of consultation requirements on the operator/registered holder, in addition to providing formal consultation opportunities for the public.

DMP has developed an engagement strategy to guide communications and community engagement. DMP's community engagement and communication activities for the shale and tight gas industry aim to achieve the following:

- Increased public and media understanding of the processes, opportunities and risks associated with shale and tight gas, and in particular hydraulic fracture stimulation, by providing timely information in a clear and open manner.
- Build and foster positive relationships by ensuring the community is kept informed of industry activities in Western Australia and that their issues and concerns are being noted, understood, and, if appropriate, acted upon.
- Enable the community to contribute and participate in the development of a safe and responsible shale and tight gas industry by providing a variety of accessible and convenient community engagement methods.

- Demonstrate DMP's robust cross-government approach for the management of the shale and tight gas industry in Western Australia by ensuring that stakeholders know what DMP's role as the State's lead regulator entails, and how it ensures approvals and conditions are complied with.
- Maintain confidence in DMP's ability and willingness to ensure safe and responsible management of the oil and gas industry by undertaking regular consultations with key stakeholders.

Addressing potential issues and impacts

Potential adverse impacts from shale or tight gas projects are addressed by the Western Australian regulatory framework and the responsible authorities. The framework explains how these potential impacts are addressed by the Western Australian Government.

Relevant issues that have been identified in relation to shale and tight gas include:

- Land access
- Flora and fauna
- Air quality
- Local amenity
- Water quality and the protection of drinking water supplies
- Protection of human health
- Induced seismicity

Registered holders of a Petroleum Exploration Permit or Production Licence are required to obtain consent from the landholder, verbal or otherwise, to access land, as listed in the *Petroleum and Geothermal Energy and Resources Act 1967*. However, registered holders are required to obtain written consent in the following cases:

- Private land not exceeding 2000 m² in area
- Land used as a cemetery or burial place

or

- Land that is less than 150 m laterally from:
 - any cemetery or burial place
 - any natural storage or accumulation of water, a spring, dam, bore or artesian well, or
 - any substantial improvement.

Formal notice to the private landowner and occupier (if they differ) must be given regarding the intention to explore or produce. The registered holder must be able to demonstrate that such a notice has been served in writing. A compensation agreement must be finalised before operations can commence. This includes a compensation agreement with the landowner, as well as the occupier if the land is being leased. Compensation for petroleum activities is for:

- damage to the land including damage to improvements or rights of way, and all consequential damage
- the landholder being deprived of possession or use of the land
- severance of adjacent land owned by the landholder.

The procedure for adjudicating any disputed compensation claim (for those directly and indirectly affected) is through the Magistrates Court. The timeframe for submitting disputes to the Magistrates Court is three months after the day the landowner/occupier was given notice of the intention to commence operations on the private land.

Any impacts to the natural environment, including the biological environment such as flora and fauna species or communities, must be addressed in the environment plan. Under the environment plan, the description of the biological environment needs to be supported by on-ground flora and fauna surveys undertaken by suitably qualified personnel and in accordance with the relevant EPA guidance statements and related technical guides.

There are several possible sources of emissions into the air from shale or tight gas operations, and these sources change over time as the operation progresses from exploration to decommissioning. The environment plan submitted to DMP must detail the anticipated emissions and how the risk of these emissions will be managed to as low as reasonably practicable and within acceptable standards and monitoring of bulk emissions, such as venting or flaring.

The establishment of a new project has the potential to create impacts on the local amenity beyond the boundaries of the title or development area. These impacts may be positive or negative, may change in scale over time and may have consequential socio-economic effects on the community. Potential issues may arise with noise, visual amenity, increased traffic, or transportation of equipment through localities. Projects that require full EPA assessment may also require a social impact assessment. Local governments play a key role in addressing these impacts, expressly dealing with issues such as noise management and traffic management.

The quality of the State's water resources is protected through a collaborative approach across Government. Agencies involved include DoW, DER, DoH, DMP and EPA where appropriate. The quality of the State's water resources are protected by addressing the following key issues:

- Petroleum well integrity – regulated by DMP through the well management plan.
- Prevention of chemical spills and leaks at the surface – regulated by DMP through an environment plan and an associated spill contingency plan.
- DMP/EPA Memorandum of Understanding – details when DMP should liaise with EPA on the approval of a project with respect to potential impacts on water resources.
- DoW Water Quality Protection Notes – outline best management practices for a variety of activities to limit the risk of water contamination to acceptable levels.

DoH regulates the State's drinking water quality. Licences issued by the Economic Regulation Authority to public water service providers require the provider to monitor its systems and report the results to DoH.

A 'public drinking water source area' (PDWSA) is a term defined in DoW policy for water sources proclaimed under specific legislation as either water reserves, catchment areas or underground water pollution control areas. PDWSAs are subject to their own government agency assessment and approvals processes that reflect the Australian Drinking Water Guidelines. The PDWSA protection framework employed in Western Australia is consistent with world's best practice and is managed by DoW and DoH. Drinking water source protection reports drafted for each PDWSA are available from DoW's website.

Protection of human health includes ensuring that any emissions from a petroleum activity meet air and water quality standards relevant to nearby populated areas. The *Health Act 1911* provides protection for public drinking water supplies. It also provides protection from pollution for any water supply or catchment area containing water intended or available for human consumption. The local government or the Executive Director Public Health can direct the closure of a water supply that is considered to be polluted.

The process of hydraulic fracture stimulation may result in minor induced, or man-made, seismicity at depth, although the tremors would normally be much too small to be felt by people at the Earth's surface. DMP requires the submission of the results of any microseismic monitoring of fracturing activities for evaluation and assessment.

Compliance and enforcement

Regulations provide the detailed requirements to achieve the objectives of legislation and they carry the force of law. Government agencies administer regulations, the mechanisms used to enforce them, and the consequences of failing to comply.

DMP enforces regulations specific to petroleum activities and projects throughout Western Australia, including shale and tight gas resources. As part of the regulatory process, DMP assesses and approves plans and undertakes audits and inspections of petroleum activities and facilities.

DER regulates emissions and discharges from prescribed premises, which may include shale and tight gas activities, to prevent pollution and environmental harm. Emissions include noise, odour, electromagnetic radiation, or discharge of waste. Waste includes liquid, solid, gaseous or radioactive matter which is discharged to the environment. DER also administers provisions for the clearing of native vegetation.

In addition, OEPA has a regulatory role in monitoring and enforcing compliance with any Ministerial conditions imposed on registered holders as part of their project approvals.

The Radiological Council of Western Australia has powers in relation to the activities involving radioactive materials. Oil and gas projects that involve the processing of materials, including naturally occurring radioactive materials, may require approval from the Radiological Council.

DoW enforces regulations specific to the allocation, management and protection of water resources, including relating to petroleum activities and projects throughout Western Australia.

When requested, DoH provides advice to other agencies, principally DMP, DER and EPA, in relation to potential health impacts from major projects throughout Western Australia and makes recommendations to identify, monitor and address potential health risks.

DPaW manages national parks, nature reserves and other natural areas to conserve and protect Western Australia's native flora and fauna. DPaW provides advice to regulatory agencies in relation to these natural areas and values.

DAA administers the *Aboriginal Heritage Act 1972*. In accordance with the State's Cultural Heritage Due Diligence Guidelines¹, resource companies in Western Australia are required to make reasonable efforts to determine if any Aboriginal sites exist in areas of exploration or development as part of the assessment process.

The Western Australian Planning Commission (WAPC) is the statutory authority with state-wide responsibility for urban, rural and regional land-use planning and land development matters. WAPC responds to the strategic direction of government and is responsible for the strategic planning of the State. WAPC operates with the support of the DoP, which provides professional and technical expertise, administrative services, and resources to advise WAPC and implement its decisions.

Local governments are involved in planning for local communities by ensuring appropriate planning controls exist for land use and development. They do this by, among other things, preparing and administering their local planning schemes and strategies. Local planning schemes contain planning controls such as designation of appropriate land-uses, residential densities and development standards. Local governments must base their planning decisions on the provisions and controls in their local planning scheme and are required to be consistent with State Government planning objectives and requirements. Local governments should be consulted to determine if a petroleum activity requires a development application under their relevant local planning scheme.

¹ *Aboriginal Heritage Due Diligence Guidelines* – <https://www.dpc.wa.gov.au/lantu/MediaPublications/Documents/Aboriginal%20Heritage%20Due%20Diligence-30-April-2013-Updated-Oct.pdf>

Glossary of terms and abbreviations

API	American Petroleum Institute
aquifer	A subsurface water-bearing geological layer of rock that has high porosity and permeability and allows groundwater extraction. Unconfined aquifers, which form the water table, have upper water surfaces that change depth through time. They are usually closer to the earth's surface than confined aquifers. A confined aquifer is an aquifer over- and underlain by layers of low permeable material that stop any movement of water out of the reservoir rock or aquifer
carbonate rock	A sedimentary rock composed of carbonate minerals (usually limestone)
casing (production casing)	Steel pipe that is cemented into a wellbore to prevent the wall from caving in and stop unwanted fluids from entering the hole from the surrounding rocks. The production casing is the pipe through which oil or gas flows from the reservoir to the surface
casing string	The casing string is the entire length of all the joints of casing in a well
Christmas tree	An assembly of valves and pipework fitted to the wellhead that control the flow of oil or gas production from the well
coal seam gas (CSG)	Natural gas that is formed within coal seams, adsorbed within the coal
conventional gas	Natural gas that is trapped in rock that is porous and permeable enough to allow it to flow naturally up a wellbore
DAA	Department of Aboriginal Affairs
DoE	Department of the Environment (Commonwealth)
DER	Department of Environment Regulation
DoH	Department of Health
DMP	Department of Mines and Petroleum
DPaW	Department of Parks and Wildlife
DoP	Department of Planning
DoW	Department of Water
emissions	Releases of gas (such as methane, carbon dioxide and hydrogen sulphide) to the atmosphere from the leakage or venting of that gas from the earth or from man-made facilities (e.g. pipes)
EP	Environment plan
EPA	Environmental Protection Authority
exploration	The first stage in petroleum extraction. Includes the search for undiscovered petroleum
FMP	Field management plan
flowback	The flow of injected fluids back to the surface following hydraulic fracture stimulation. The fluid is normally water
formation	A rock layer with similar composition and properties. Each formation is unique to a location on Earth
fracture	Any break in a rock formation or layer. Generally on the order of centimetres to metres in length. May be naturally occurring or man-made
Gm³	Giga or billion (10 ⁹) cubic metres. Metric unit of measure for volumes of natural gas
groundwater	Water found underground in the cracks and spaces in soil, sand and rock. It is stored in and moves slowly through geologic formations of soil, sand and rocks called aquifers
hydraulic fracture stimulation	The fracturing of rock with a liquid under high pressure to create artificial openings and cracks in the rock to increase the rock's permeability and allow more fluid to flow into a wellbore
induced seismicity	Refers to typically minor earthquakes and tremors that are caused by human activity. Most induced seismicity is of a low magnitude and cannot be felt by humans on the Earth's surface
instrument holder	The person who holds the legal authority (instrument) to do the activity
integrity (of a well)	Application of technical, operational and organisational solutions to reduce risk of uncontrolled release of formation fluids throughout the life cycle of a well

OEPA	Office of the Environmental Protection Authority
operator	Person or company responsible for undertaking an activity. This is normally the registered holder of the title
permeability	The ability, or measurement of a rock's ability, to transmit fluids. A measure of the connectedness of pores within a rock
porosity	The amount of space between the particles that make up a rock
prescribed premises (also known as licensed premises)	Under the Environmental Protection Regulations 1987, refers to premises (category 10, meaning wells or category 11 meaning other, e.g. facility) where commercial oil or gas production is greater than 5000 tonnes per year
production	The stage of petroleum extraction that follows exploration. Involves bringing the hydrocarbons up the wellbore for removal
proof of concept	To demonstrate the feasibility of an idea or method, to verify that the concept or theory has the potential of being used
registered title holder or registered holder	In relation to a permit, drilling reservation, lease, licence special prospecting authority or access authority—under the <i>Petroleum and Geothermal Energy Resources Act 1967</i> or <i>Petroleum Pipelines Act 1969</i> : the person whose name is for the time being shown in the Register as being the holder of the title. Equivalent terms are lessee, licensee, and permittee
PDWSA	Public Drinking Water Source Area
proppant	Solid material such as sand or ceramic beads added to fracturing fluids to keep a fracture open following and during a hydraulic fracture stimulation activity
reservoir	A rock formation in the subsurface that accommodates an accumulation of hydrocarbons/water
sandstone	A sedimentary rock composed mainly of sand-sized minerals or rock grains
sedimentary basin	A low area in the Earth's crust, of tectonic origin, in which sediments have accumulated and are ultimately converted to sheet-like layers of different types of rock. May be up to 12 km deep in Western Australia
shale	A sedimentary rock composed of clay-sized particles that is laminated or layered
shale gas	Natural gas generated and remaining in a shale formation
shale oil	A crude oil generated and remaining in a shale formation
Tcf	Trillions (10^{12}) of cubic feet. Field unit of measure for volumes of natural gas
tight gas	Natural gas trapped in very low permeability and low porosity reservoir rocks, sandstones and limestones. Tight gas reservoirs are generally defined as having less than 0.1 milliDarcy (mD) matrix permeability and less than 10 per cent matrix porosity
unconventional	Oil or gas resources which cannot be explored, developed and produced by conventional processes just in using the natural pressure of the wells and pumping or compression operations. Also used to refer to shale gas, shale oil, tight gas and coal seam gas
WMP	Well management plan
wellbore (borehole)	A shaft or well bored into the ground for extraction of water or petroleum
wellhead	The equipment at the surface of the well casing to which the Christmas tree is attached
WAPC	Western Australian Planning Commission



Government of Western Australia
Department of Mines and Petroleum
Mineral House, 100 Plain Street
East Perth, Western Australia 6004

Tel: +61 8 9222 3333
Fax: +61 8 9222 3862
Email: shaleandtightgas@dmp.wa.gov.au

Published August 2016
DMPAUG16_4425

www.dmp.wa.gov.au