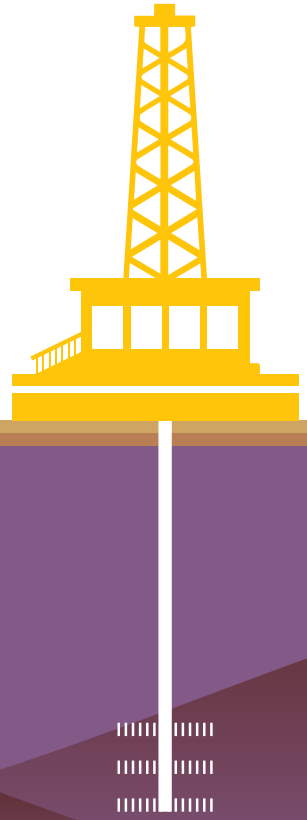
Hydraulic fracturing



This information sheet explains how government agencies manage hydraulic fracturing in New Zealand.

New Zealand Government

NEW ZEALAND PETROLEUM & MINERALS

Ministry for the Environment

Environmental Protection Authority
Te Mana Rauhī Taiao

Department of Conservation
Te Papa Atawhai

Nō te rere moana Aotearoa
MARITIME NEW ZEALAND

WORKSAFE NEW ZEALAND

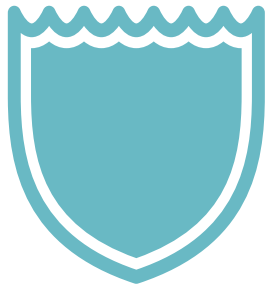
Hydraulic fracturing, commonly known as ‘fracking’, has received public attention in the last few years.

Hydraulic fracturing makes it possible to extract oil or gas from dense rock. The process injects water, proppant (sand or ceramic beads) and a very small proportion of chemicals into a well at high pressure. This creates cracks in the rock. The proppant keeps the cracks open, creating channels the oil or gas can travel through to the well. Hydraulic fracturing is only effective with rock that has extremely low permeability (the ability of liquids or gases to pass through the rock).

Hydraulic fracturing in New Zealand

- Hydraulic fracturing has been used commercially for more than 60 years around the world and was first introduced in New Zealand in 1989.
- Since then, more than 60 wells have been hydraulically fractured, in most cases to improve the flow of gas from sandstone reservoirs in Taranaki.
- Hydraulic fracturing was also used in trials to extract coal seam gas in Southland, the West Coast and Waikato between 1997 and 2011.
- New Zealand has an abundance of what is called ‘tight’ petroleum, which is oil and gas held tightly in rock. This includes some sandstone reservoirs in onshore Taranaki and shale onshore along the East Coast of the North Island. Shale is very fine grained mud rock.
- Hydraulic fracturing allows areas that are otherwise not possible to develop, to be made economically viable.

Regulation of hydraulic fracturing



The New Zealand oil and gas industry is regulated by central government agencies through legislation and by regional and district councils (local authorities) through resource management requirements. The Guide to Government Management of Petroleum, on the New Zealand Petroleum and Minerals (NZP&M) website, provides more detail on the regulatory process.

Hydraulic fracturing is regulated under five statutes:

1. Resource Management Act 1991 (RMA)

Any drilling operation on land (and out to 12 nautical miles offshore) is subject to the RMA. This is administered by local authorities. The RMA requires that adverse environmental effects of a proposed activity are avoided, remedied or mitigated.

The type of resource consent required for hydraulic fracturing and related activities (such as drilling and waste disposal) will depend on the nature and scale of the operation, its effects on the environment, and what is permitted in the relevant local authority plan.

Resource consents can be publicly notified, but this decision is made by local authorities on a case-by-case basis. It depends on the level of environmental effects associated with the activity. For further information about the resource consent process, see the Ministry for the Environment's website.

If granted, a resource consent may include conditions on the operator which are designed to address potential adverse effects on the environment, and potentially affected persons such as nearby neighbours, businesses and others.

2. Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012 (EEZ Act)

While hydraulic fracturing has been used in offshore oil and gas operations globally (for example, in the Gulf of Mexico) it has not been used in New Zealand's offshore environment to date.

If it were to be proposed here in our Exclusive Economic Zone (the area beyond 12 nautical miles from the coast) the activity would be considered under the EEZ regime. This regime is administered by the Environmental Protection Authority (EPA).

3. Hazardous Substances and New Organisms Act 1996 (HSNO Act)

Chemicals used as part of petroleum exploration are subject to the HSNO Act. It also covers surface storage and containment facilities at well sites. The HSNO Act is implemented by the EPA.

In New Zealand hydraulic fracturing fluid is made up of 98 to 99.5% water and sand (or ceramic beads). The remaining 0.5-2% is made up of chemical additives which must be approved by the EPA.

The majority of the chemicals are biodegradable and many are commonly used for other purposes, such as in everyday household products.

The chemicals used include:

- a friction reducer to make it easier to pump and evacuate fluid
- natural plant-based gel to hold sand in place
- gel management system to keep the gel stabilised while sand moves into fissures
- clay stabiliser to prevent any clay in the reservoir rock from plugging the reservoir when it comes in contact with water
- corrosion inhibitor to stop the well casing from corroding
- bactericide to stop corrosion caused by bacteria.

The Ministry for the Environment guidelines **Managing Environmental Effects of Onshore Petroleum Development Activities (Including Hydraulic Fracturing)** were released in 2014. These guidelines clarify the roles and responsibilities of regulatory agencies and help councils manage any potential environmental effects under the RMA. These guidelines can be found on the Ministry for the Environment website.

4. Health and Safety at Work Act 2016 (HSW Act)

The **Health and Safety at Work (Petroleum Exploration and Extraction) Regulations 2016**, under the HSW Act, outline requirements for the design, construction, operation, maintenance, suspension and abandonment of all petroleum operations including drilling wells.

The regulations were first introduced in 2013, and updated in 2016, to strengthen the management of hazards and safeguards associated with drilling wells. This includes ensuring the integrity of wells is maintained at every stage of an operation.

The HSW Act and its regulations are implemented by the High Hazards Unit, part of WorkSafe New Zealand (WorkSafe).

5. Crown Minerals Act 1991 (CMA)

Under the CMA, a petroleum company is required to have a permit from NZP&M in order to carry out prospecting, exploration or mining activities. Hydraulic fracturing is not considered when granting a permit – as it is an environmental consideration under the legislation referred to above.

Under the CMA a petroleum company is also required to have a land access arrangement with the landowner or occupier. For petroleum activity on conservation land, land access arrangements must be sought from the Department of Conservation (DOC).

In assessing whether to grant access, DOC considers various criteria including safeguards against any potential adverse effects of carrying out the proposed petroleum activities, and the purpose for which the land is held by the Crown. Hydraulic fracturing could be considered during negotiations for a land access arrangement.

See the Land Access information sheet on the NZP&M website for more general information about land access.

Hydraulic fracturing: from planning to product

1 Planning

Before any hydraulic fracturing project begins, relevant aspects such as the underlying geology and the orientation of faults are considered. This information is used by engineers to establish the best way to stimulate production and minimise potential negative environmental impacts.

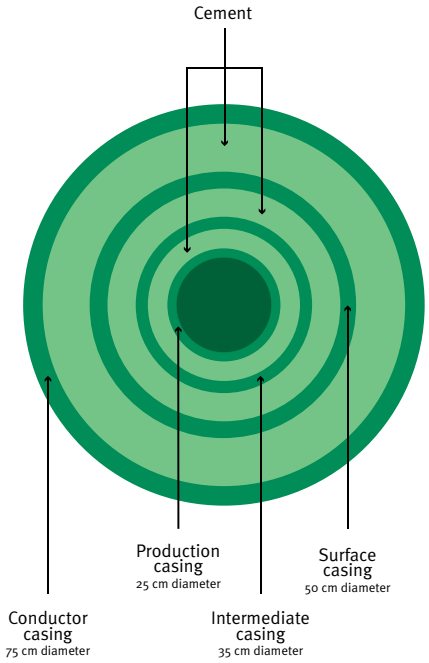
Hydraulic fracturing is a very expensive process so the exact size and location of the fractures are precisely modelled beforehand.

Permits or consents must be gained from the appropriate authorities and a land access arrangement must be negotiated with the landowner and/or occupier. See more on land access on the NZP&M website.

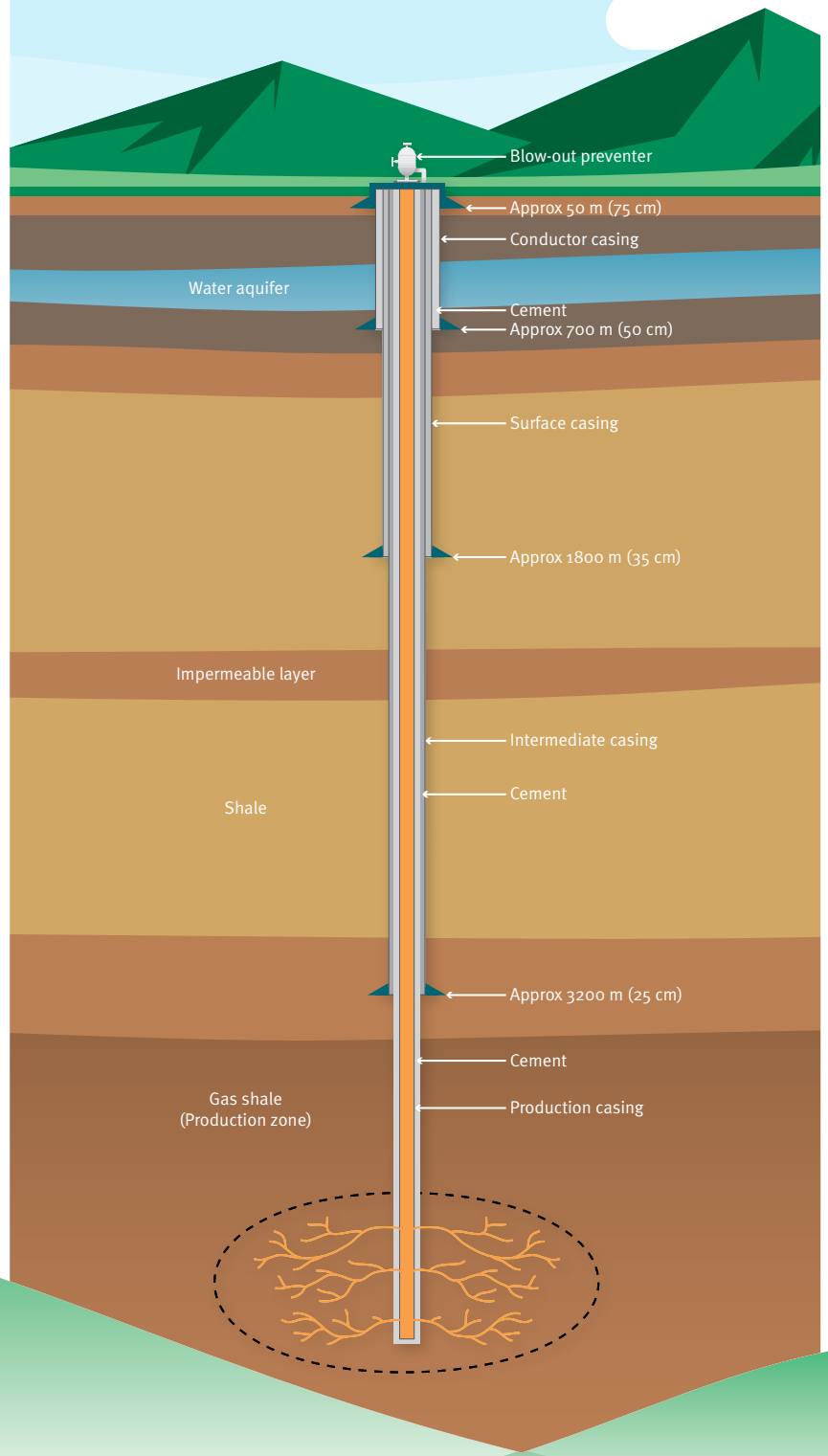
2 Design and construction of wells

An important factor in managing environmental risks is the design and construction of the well.

In New Zealand, when a well is drilled it is lined with a steel casing, which is held in place with cement. In the shallower section of a well, where it may pass through an aquifer, multiple layers of steel and cement are generally used.



Petroleum well casings



Petroleum well after hydraulic fracturing
Based on a Mangahewa-type well

In contrast to places like onshore United States, New Zealand's petroleum reservoirs are far below aquifers, usually at depths greater than three kilometres.

Wells are built, operated and maintained to ensure the potential for an unintended escape of fluids is kept to a minimum. These measures are collectively referred to as "well integrity".

Ensuring well integrity from an environmental perspective is managed by local authorities under the RMA. Well integrity in relation to its potential impacts on the health and safety of people is regulated by WorkSafe's High Hazards Unit under the Health and Safety at Work (Petroleum Exploration and Extraction) Regulations 2016.

3 Perforating the well

Hydraulic fracturing can be undertaken on vertical or horizontal wells. This could be at the bottom of the well or at various points along its length. Perforations are made in the well casing at appropriate points to allow fracking fluid to flow into the rock, and oil or gas to flow into the well.

In New Zealand petroleum operations, hydraulic fracturing has been undertaken at depths of between 1700 and 5000 metres below the surface.

4 Water use

Most operators undertaking hydraulic fracturing in New Zealand bring in water by truck from a municipal supply. Water can also be allocated by the regional council, under the RMA.

The volume of water needed is dependent on the characteristics of the rock at that specific site. Water used in hydraulic fracturing operations for tight sand formations in Taranaki has ranged from around 500 to 1500 cubic metres per well. Larger quantities would be needed to unlock oil or gas in shale rock.

5 Transporting and storage of chemicals

Chemicals used in fracking fluid are transported to the well site in protective containers and are stored in purpose-built tanks. The storage of hazardous substances is regulated by the EPA through controls set under the HSNO Act and transport is managed under **NZTA's Land Transport Rule: Dangerous Goods** which is enforced by Police.

6 Pumping and forming fractures

Before hydraulic fracturing begins, tests are undertaken to assess the properties of the rock and identify the pressure required to initiate a fracture.

Operators can then control the fluid volume and rate of injection to make sure the fractures form in the correct parts of the petroleum reservoir.

The fracking fluid is pumped under pressure down the well and when it reaches the perforated area it flows into the reservoir rock.

The fluids are kept under pressure for a short period of time (usually a matter of minutes in the initial test). This pressure creates small fractures in the targeted rock. The final fractures are a few metres to several hundred metres long. The pumping operation lasts for 30 to 60 minutes. Operators calculate the direction of the fractures and can monitor the size of fractures as they are being created, based on the volume of fluids being injected.

7 Collecting hydraulic fracturing fluid

When the pressure is released from the well, up to 75 per cent of the fracking fluid flows back to the well head at the surface where it is collected for safe disposal. This is called the “clean-up” phase.

The proppant remains in the reservoir, propping open fractures to create a path for oil or gas to flow through. Most of the remaining fracking fluid is brought back to the surface during the early stages of production as oil or gas is extracted. A relatively small amount cannot be recovered and remains underground in the petroleum reservoir.

8 Disposal of hydraulic fracturing fluid

Management of recovered hydraulic fracturing fluid must be done in accordance with the RMA. Requirements are often similar to the management of waste water for businesses such as farms, mills, mines and processing plants.

Waste water is collected and kept in lined settlement ponds or storage tanks. It can be chemically or mechanically treated or diluted to meet the levels of purity required by the resource consent. It is fairly common internationally for the fluid to be recycled and reused for further hydraulic fracturing operations.

The waste water from hydraulic fracturing operations can also be disposed of deep underground by reinjecting it into existing wells which no longer produce oil or gas. This is the main means of disposing of hydraulic fracturing fluid in Taranaki and requires a resource consent.

The resource consent process typically includes an assessment of the geology of the area (including the existence of impermeable layers of rock, called geological seals), well integrity to ensure fluid cannot escape, and potential impact on any faults. Conditions on consents can include ongoing reporting of injection pressures, monitoring of the underlying geology for any impacts and testing of ground water.

9 Restoring the environment

When a well has come to the end of its life, operators rehabilitate the site to return it to its previous condition, if required by a resource constent. Regular, ongoing monitoring of the surrounding environment is undertaken during the rehabilitation process.

Managing risks

As with any industrial activity, there are risks that need to be carefully managed. Hydraulic fracturing has not been linked to any environmental incidents in New Zealand.

Contamination of aquifers

The risk of contaminating an aquifer during the process of hydraulic fracturing is low.

Wells have thick steel casings which are cemented in place and form a barrier against fluids 'leaking' into aquifers. Systems on the surface which manage pressure in the well during extraction also help ensure the potential for unplanned leaks are kept to a minimum.

The design, construction and operation of a well ensure well integrity. Well integrity is regulated by local authorities and Worksafe.

In addition, hydraulic fracturing is typically used in shale and tight gas reservoirs which are usually very deep below aquifers. The reservoirs and aquifers are separated by impermeable layers of rock, called geological seals.

These rock layers stop oil, gas, drilling muds and hydraulic fracturing fluids from making their way to the surface.

The likelihood of petroleum or fluids reaching an aquifer through a fracture is extremely low. This is because of the vertical separation of the petroleum layer and the aquifer – which can be kilometres apart. The hydraulic fracturing activity is specifically designed so that the fractures remain inside the layer of petroleum-bearing rock.

Surface spills and chemical additives

There is a risk of chemical spills occurring at the surface, a risk shared by many work sites in different sectors.

Some of the additives used in hydraulic fracturing operations can be toxic to humans and/or the environment, particularly when they are in concentrated form – such as when they are being transported to the well-site. After being diluted, some additives may still be harmful to human health if ingested or if a person comes into direct contact with them, and to organisms in the environment.

Whether hydraulic fracturing fluids are harmful depends on what kind of additives are present, at what concentration, and whether they are released into the environment.

The EPA and/or local authorities strictly regulate the handling, storage, transport and disposal of chemicals and hydraulic fracturing fluids, requiring appropriate contingency plans to manage spills and discharges, should they occur. For example, resource consents can require the preparation of a contingency plan and ongoing monitoring and testing of local fresh water resources.

Seismic activity

Injecting fluids deep underground, through hydraulic fracturing or deep well injection, has been known to induce minor (micro) seismic activity in New Zealand.

According to GNS Science, seismic activity associated with hydraulic fracturing is generally less than magnitude 2.0.

In 2012 GNS Science assessed seismic activity associated with hydraulic fracturing in the Taranaki region between 2000 and mid-2011. They found no evidence that hydraulic fracturing activities (including the deep well injection of waste fluids) in Taranaki had any observable effect on natural earthquakes of magnitude 2.0 or larger.

The study concluded that, at a depth of 2-4km, an earthquake of magnitude 2.0 is likely to produce surface vibrations similar to that caused by a nearby passing truck, but no more.

Before drilling begins, operators assess information about fault lines in the area to establish where the fracture will go and ensure it is in the petroleum reservoir.

Injecting hydraulic fracturing fluid into faults is actively avoided.

How operators monitor seismic activity or vibration can be considered as part of a resource consent application.

The Parliamentary Commissioner for the Environment's investigation into hydraulic fracturing

The Parliamentary Commissioner for the Environment (PCE), Dr Jan Wright, has released two reports that relate to the management of petroleum operations such as the use of hydraulic fracturing in New Zealand.

The PCE's interim report **Evaluating the environmental impacts of fracking in New Zealand**, which was released in November 2012, concluded that hydraulic fracturing can be effectively managed providing that operational best practice is followed and enforced through regulation.

Four findings were made on processes essential for good management of environment risks:

- Choose the well site carefully.
- Design and construct wells to prevent leaks.
- Prevent spills and leaks on the surface.
- Store and dispose of water with care.

Similar findings were made in the United Kingdom in a report on hydraulic fracturing by the Royal Society **www.royalsociety.org/policy/projects/shale-gas-extraction/report/**

The Ministry for the Environment guidelines **Managing Environmental Effects of Onshore Petroleum Development Activities (Including Hydraulic Fracturing)** were released by the Government in response to the PCE's interim report.

These guidelines are designed to ensure hydraulic fracturing is carried out in a robust, controlled and well regulated manner.

In June 2014 the PCE released a final report entitled **Drilling for oil and gas in New Zealand: Environmental oversight and regulation**. This report has much wider scope and explores the whole process of drilling for oil and gas, from choosing a well site through to abandonment of the well.

The report makes six recommendations for managing the environmental risks of the onshore oil and gas industry. The recommendations relate to:

- providing national direction to local councils through a national policy statement
- improving regional plans
- ensuring a well has integrity
- ensuring the industry bears the cost of present and past petroleum operations that require remediation
- recommending regional councils enforce the controls on hazardous substances
- dealing with solid waste from oil and gas wells.

The PCE found that "extensive reform of New Zealand's laws, agencies, and processes is not yet required for effective management of the local environmental effects of onshore oil and gas extraction". She also concluded that "New Zealand's oversight and regulation is not currently adequate for managing the environmental risks of oil and gas drilling" and noted that the Government has an opportunity to put in place policies and rules while the country is mostly in an exploration phase.

The Government has welcomed the PCE's final report and Ministers are considering the PCE's recommendations.

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