PEMBINA Institute

Landowners' Guide
to Oil and Gas Development

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all new and revised

Section 7

Potential Environmental Impacts During Oil and Gas Operations

photo: Roberta Franchuk, Pembina Institute

7. Potential Environmental Impacts During Oil and Gas Operations

This section examines in depth some of the potential impacts of oil and gas operations on air, water and land. Additionally, it outlines the process for conservation and reclamation before and after development occurs (further expanded upon in section 8).

What's in this section

The regulatory system is fundamentally based on industry self-reporting. As a result, the Alberta Energy Regulator (AER) inspects only a small proportion of all wells, pipelines and other facilities each year, focusing on operations where there is an inherent high risk or with known or emerging issues, as well as randomly inspecting sites to establish a representative sample set.[1] Given the AER's limited resources relative to the size of the industry, as a landowner or occupant you can play a valuable role by looking out for and documenting any problems with operations.

7.1 Oil and gas facilities

If you have a well, pipeline or facility on your land, you should regularly inspect the land around the site, especially if livestock are in the area, to ensure that there are no spills or leaks and that gates are closed and fences are intact.

Upon identifying any issues, unless it is an emergency, you should first discuss them with the company and then register your issues with the AER. In an emergency, contact the company operator through its 24-hour emergency number[2] and the AER Energy and Environmental Emergency 24-hour Response Line (1-800-222-6514) as soon as you can do so safely.

If the company fails to promptly resolve any issue to your satisfaction, then you should ask for help from the AER. The AER deals with complaints related to a company's operations at the lease site, problems that directly affect the environment, and issues related to seismic activity or activity on public lands. The Farmers' Advocate Office can also provide advice.

7.1.1 Complaints and field inspections

If a problem is reported to the AER, the regulator may require the company to fix it within a specified timeframe. The AER should be informed if the company does not comply within the given time period. The AER may impose a penalty according to an escalating scale of consequences, with higher penalties for serious offences and repeat offenders. Penalties can include temporary or long-term suspension of operations, refusal of applications, closure or abandonment of wells, and prosecution.

The AER maintains a compliance dashboard where you can find summaries of incidents, investigations, and enforcement activities.[3]

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[1] AER, "Inspection and Audits." https://www.aer.ca/regulations-and-compliance-enforcement/compliance-and-enforcement/inspections-and-audits

[2] Companies must provide their 24-hour emergency number in their emergency response plan, as well as on an obvious sign at the entrance to their well or facility site.

[3] AER, "Compliance Dashboard." http://www1.aer.ca/ComplianceDashboard/index.html

7.1.2 Pipelines

If a company does not clear away debris from a pipeline right-of-way or fails to restore the topsoil, cultivate and seed the land properly, or deal with drainage problems, the landowner or occupant should contact the company. The company should also be contacted if soil sinks in the pipeline trench, the pipeline becomes exposed, or there are any other observable impacts.

You should also register your complaint with the AER. If the company fails to take suitable action, contact the regional inspector at the AER. The Farmers' Advocate Office may also be able to help.

If there is a dispute about damages on the pipeline right-of-way, it is possible to go to arbitration. The arbitration process is governed by the Alberta Arbitration Act. If the damage occurs off the right-of-way line, the problem can be brought before the Land and Property Rights Tribunal. It is advisable to have this process defined in the pipeline agreement to ensure that, if issues arise, both you and the company have a mutually agreed upon process to follow.

If you suspect a pipeline leak, call the company and the AER immediately. The first sign of a leak could be an odour, but a slow leak might be indicated by a change in plant growth close to the leak. A company must report a pipeline leak to the AER. A failure to report or an unsatisfactory response by the company may result in the AER ordering the pipeline to be shut in or replaced.

7.1.3 Oil and gas wells

The AER requires companies to test new oil and gas wells for surface casing vent flows and gas migration and to repair or monitor those with any leaks. A well must also be tested before it is abandoned.[4] These requirements are important because if wells are not properly cased or abandoned, gas, oil or saline water from deeper formations may escape from the wellbore and contaminate shallow potable-water aquifers. Gas migration — the leakage of gas outside an oil or gas well — can occur if wellbore casings are not properly cemented or if earth tremors from activity in the area have damaged the casing.

7.2 Air emissions

Flaring and venting from wells, gas plants and other facilities and the associated smoke, odour, and potential exposure to hazardous air pollutants have long been a source of concern for those living and working near oil and gas operations. Air emissions are of particular concern for hydraulic fracturing operations, which see well pressures rising and falling in cycles. Gas flows

[4] AER, *Directive 087: Well Integrity Management* (2025). https://static.aer.ca/prd/documents/directives/directive-087.pdf

to the surface when well pressures drop, and emissions management can be difficult without gas capture technology and regulations to prompt operators to reduce venting and flaring.

7.2.1 Flaring and venting

There are several types of flaring and flare systems:

- well test flaring (see section 7.2.3)
- coalbed methane flaring
- hydraulic fracture flaring
- solution gas flaring and venting
- gas processing plant byproduct flaring
- temporary flares
- continuous flares
- emergency flares

For background information on flaring, see *Flaring: Questions + Answers*.[5]

Research done by the former Alberta Research Council showed that a flare can release a large number of air pollutants, including unburned hydrocarbons and other harmful substances that result from incomplete combustion. The products of incomplete combustion depend on the constituents in the gas that is burned but can include the aromatic hydrocarbons benzene, toluene, ethylbenzene and xylene (BTEX),[6] polycyclic aromatic hydrocarbons and, if the gas is sour, hydrogen sulphide (H_2S). When burned, H_2S produces sulphur dioxide, which is also harmful.

If problems are occurring with flares, you should first contact the company and make them aware of the situation. You can also call the AER's Energy and Environmental Emergency 24-hour Response Line to register your complaint, asking them to investigate or take other action.[7] Signs of problems with flaring include visible black smoke or plumes, frequent or long-lasting flares, continuous flaring for projects that have not been approved for such, and abnormally intense flames. If you experience health issues that seem to be associated with flaring activity, take detailed notes about flaring activity nearby.

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[5] Robert D. Bott, *Flaring: Questions + Answers* (Canadian Centre for Energy Information, 2007). https://www.ccacoalition.org/sites/default/files/resources/2007_Flaring-questions-and-answers.pdf

[6] Mel Strosher, *Investigations of Flare Gas Emissions in Alberta,* Special Report 005 (1996). https://static.ags.aer.ca/files/document/SPE/SPE_005.pdf

[7] Each call is triaged and forwarded to the appropriate field centre for a response.

You should document issues, especially if they are ongoing: take photographs of flares and smoke, and keep records of the date, nature of the occurrence, and duration. Be sure to include something in the photograph to provide scale and to identify the location where it was taken — such as the company sign next to the site. Ideally, you should use a camera that includes a date and time stamp on the image or a smartphone with the date and time recorded in the image properties. This is especially important in cases where the flaring event may conclude before a field inspector can come to the site to investigate.

When documenting any issues you have with an operation, include the time you spent investigating the problem, associated damages, and other relevant details. See Appendix C for ideas of what you should document.

Venting of gases can also pose problems. Venting occurs when solution gases from oil wells, batteries or storage tanks are released unburned to the air. Some venting may also occur from compressor vents, instrument gas stations, pneumatic devices, and dehydrators. This release of unburned hydrocarbons to the atmosphere creates odours and exposure to potentially harmful substances. Vented gas also contributes to global climate change and wastes a non-renewable resource. Current AER regulations set standards for venting and allow venting of small volumes of gas where it is not considered practical to recover or flare it. For example, continuous venting of gas containing H_2S must not exceed the *Alberta Ambient Air Quality Objectives and Guidelines*[8] for H_2S or result in odours outside the lease boundary. There are also limits on the total amount of benzene that may legally be released.[9]

Flaring and venting can be eliminated in various ways, such as by piping the gases for other processing, using the gas on site to drive equipment or provide heat, or pooling gas from several small sources and sending it via pipeline to processing plants. When deciding about flare reductions, a company must consider economic, social and environmental factors, including the proximity of nearby residents.

While emissions from solution gas flares and gas plant flaring have received most of the attention, there is also concern about flaring and venting from pipeline maintenance. Pipeline maintenance is often preceded by purging the line and flaring or venting the gas directly to the atmosphere. To inspect the condition of pipeline walls, a cylindrical device known as a “smart pig” is sent along the pipe; it detects and sends back data on cracking and corrosion.

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[8] Alberta Environment and Protected Areas, *Alberta Ambient Air Quality Objectives and Guidelines* (2024). https://open.alberta.ca/publications/alberta-ambient-air-quality-objectives-and-guidelines

[9] AER, *Directive 039: Revised Program to Reduce Benzene Emissions from Glycol Dehydrators* (2025). *https://www.aer.ca/regulations-and-compliance-enforcement/rules-and-regulations/directives/directive-039*

7.2.2 Incinerators

In some circumstances using an incinerator may be preferable to flaring. Some types of incinerators can burn with high efficiency and thus minimize odour and air pollution, including greenhouse gas emissions.[10] Unlike flares, the efficiency of well-designed incinerators is not affected by cross-winds. Additionally, an incinerator produces less noise and eliminates the visible flame associated with a flare.

A company will consider a variety of factors when determining whether to use a flare or incinerator, including cost, volume of gas flow, proximity of houses, and land topography. Although the emissions from an incinerator may be less than a flare, they are released closer to the ground and may not disperse as effectively. Thus, if a well is close to a dwelling located in a hollow, a flare stack may be considered preferable to an incinerator.

7.2.3 Well testing

After a company has drilled a well, it must be tested to determine characteristics about the oil or gas being produced, rate of production, and other factors for production. During this testing, reservoir fluids and gas can be produced and must be managed accordingly. The reservoir fluids can be stored on site before being transported for waste management. The produced gas, after it is separated from the fluids, can be transported in a pipeline for processing or can be flared or vented at a well site. If flaring or venting is used, air quality might be affected.

The recommendation for producers is to first try to avoid any gas emissions at all. If they cannot be avoided, the emissions should be minimized. Gas capture is preferred to flaring, and flaring is preferred to venting.

The AER allows 21 days to complete well testing. Although a company can apply for a longer test period under specific circumstances, any flaring and venting during well testing must not exceed 72 non-consecutive hours.[11] Flaring approved by the AER must conform to the *Alberta Ambient Air Quality Objectives and Guidelines*. The challenge is that there are no requirements for ongoing air monitoring at wells that do not contain H_2S, and in some instances it will not be known if these guidelines are exceeded. If you believe that operations are exceeding these standards, it is important to inform the AER immediately so that they may be able to respond to your complaint in time to measure the air quality event. Even in a case where the individual

[10] See, for example, Questor Technology Inc. at http://www.questortech.com/. Some so-called incinerators are similar to low-level shielded flares and do not achieve the high combustion efficiency of refractory incinerators. An efficient, well-designed incinerator should not require the addition of propane to the gas to ensure continuous burning.

[11] AER, *Directive 060*, section 3.2.

project may still be compliant, it can be helpful to register your complaints with the AER so they can see over time that this may be an area of concern.

Well test flaring may emit pollutants that can damage vegetation and affect human and animal health. As explained in section 5.3, setbacks are intended to protect people from exposure, but people may wish to be alerted during well tests. The AER requires a company to notify its local field centre, the local municipality, and rural residents before testing an oil well or sour gas well using a flare that will last more than four hours in a 24-hour period. The requirements are different for oil wells and gas wells, but the minimum notification radius ranges from 0.5 km to 3 km depending on the composition of the gas being flared, duration of the flare and the gas volume discharged.[12]

Companies are not automatically required to notify adjacent landowners or occupants when they test flare for a shorter duration. However, the AER suggests that companies conduct "good neighbour" operations, where they notify residents who have identified themselves as being sensitive to or interested in emissions from a facility.

You may want to arrange for livestock to be moved upwind or away from the flare. If you or others suffer from a respiratory illness, you can negotiate with the company to ensure that it notifies you when it plans to carry out its well test flaring so you can leave the area at that time. You may want to make arrangements for the company to delay the start of a well test or to stop a test if meteorological conditions are unfavourable and would result in pollutants concentrating at ground level. Although regulations require companies to ensure ground-level concentrations of pollutants do not exceed maximum allowable levels, general ambient monitoring is not always required.

In an established area where pipelines are already nearby, a company may be able to greatly reduce well test flaring by conducting an in-line test through a pipeline to a processing facility. However, a short period of flaring will probably be required to remove any remaining fluids from the well after it is drilled, since the fluids could cause corrosion if released into the pipeline.

If small quantities of solution gas are measured in an oil well, it may not be economic for the company to collect and pipe the gas. Instead, a company may want to install a permanent flare stack or incinerator for production from such a well. Operators with continuous solution gas flares, incinerators or vents are expected to provide public information packages with the following information:[13]

[12] *Directive 060*, Table 2.

[13] AER, *Directive 060*, section 4.7.1.

- the definition of solution gas and information on its conservation and use
- an explanation of solution gas flaring, incineration, and venting management options and the decision process
- a summary of analysis completed to determine that flaring, incineration, or venting is needed
- information on general flare/vent performance requirements and reduction targets
- descriptions of specific actions the licensee or operator will take to eliminate or reduce flaring, incineration, or venting or improve the efficiency of the flare, incinerator, or vent based on the evaluation
- a list of industry, AER, and government contacts that are related to public consultation and relevant to the project

Air emission issues at compressor stations are described in section 4.3.2. Dehydrators, which may be located at well sites, are described in section 4.3.3.

7.2.4 Odour

Odour is a frequent cause of complaints to the AER. Venting of gases (especially from crude oil and bitumen batteries), tank venting, leaking tank seals or ineffective vapour recovery units on storage tanks can cause odours. If there is an odour, it is important to notify the company and the AER at once and ask that action be taken to locate and stop the source. If the odour is caused by H_2S, see section 6.3 for information on evacuation in emergency situations. If you are concerned that you or other individuals in your household might be affected by the emissions, you may wish to leave the area. If you leave because of odours when there is no general emergency, you should notify the AER as to the reason that you left.

If you are troubled by a recurring odour, notify the AER of each event or on a regular basis. Keep a record of when events occur, noting the wind direction, wind strength, ambient temperature, and any other weather conditions during the event. You should also write down a description of the odour during each event, as that may help in finding the cause of the odour.

7.2.5 H_2S exposure

While Alberta Health has reviewed the health effects associated with short-term exposure to low levels of H_2S,[14] there are still many gaps in our knowledge about the long-term effects of exposure. However, there is growing evidence that chronic and low-level exposures to H_2S can be associated with ongoing health impacts.[15] The specific risk of low-level exposure to H_2S for the general population or sensitive people is not known.

If you have a problem, ask the AER to arrange a monitoring unit for your area. Sometimes the AER will require a company to conduct its own air monitoring when they have received a complaint, or the AER may work with Alberta Environment and Protected Areas and partner airshed organizations to conduct further monitoring, as they may have mobile monitoring equipment that can measure more substances at lower concentrations.

It is important that any monitoring equipment is properly located in an area where the air pollution is high and where conditions lead to bad air quality. Thus, the equipment should be downwind, where the emissions seem to be the worst when the wind speed is low, or where air inversion conditions are present. Landowners or occupants can suggest what they consider to be the best monitoring location based on their experiences.

7.3 Drilling wastes

Well drilling generates large volumes of waste in the form of drilling mud, drill cuttings and flowback fluids, which require storage and disposal. Spills and leaks of drilling fluid, hydrocarbons or water produced during drilling operations must be carefully cleaned up, as required by the regulations, to minimize any contamination of soil and water.

Drilling mud is circulated down the drill pipe to cool the drill bit and maintain the desired pressure in the well. The mud is prepared and stored in tanks on or near the well site and circulated into the wellbore as needed. The mud is then returned to the surface, carrying the drill cuttings with it. The mud may be a water-based clay mixture, but if there is a risk of encountering a water-sensitive subsurface rock formation, hydrocarbon-based muds are used. These hydrocarbon-based drilling muds have historically had a diesel fuel base. Mineral oil and canola oil are less toxic alternatives to diesel fuel but are typically more expensive and may have

[14] Alberta Health Services, *Alberta Health: Acute Exposure Health Effects of Hydrogen Sulphide and Sulphur Dioxide*. https://www.albertahealthservices.ca/assets/wf/eph/wf-eh-alberta-health-acute-exposure-health-effects-of-hydrogen-sulphide-and-sulphur-dioxide.pdf

[15] Stuart Batterman, Amelia Grant-Alfieri, and Sung-Hee Seo, "Low level exposure to hydrogen sulfide: a review of emissions, community exposure, health effects, and exposure guidelines," *Critical Reviews in Toxicology* 53, no. 4 (2023), 244–295. https://pubmed.ncbi.nlm.nih.gov/37431804/

other operational challenges. Rock cuttings from the active drilling zone are normally separated from the drilling mud and collected in a pit (commonly referred to as a "sump") or in large tanks. They ultimately form part of the drilling mud waste when the drilling project is complete.

The chemical composition of drilling muds varies depending on the products that must be added to address the challenges at each well. Potentially toxic products include bactericides, emulsifiers, lubricants, shale control inhibitors and surfactants.[16] Drilling muds may also become contaminated with hydrocarbons or salts that are brought to the surface from deep underground formations.

Drilling muds, flowback fluids, and wastewater from hydraulic fracturing activities may also contain higher concentrations of naturally occurring radioactive materials (NORMs). This may include uranium, thorium, radium (and their decay products); potassium-40; and lead-210/polonium-210.[17] Deposits of NORMs occur naturally in different concentrations at different depths, depending on the underlying geology. Specifically, NORMs can accumulate in shale or clay-rich layers and are therefore often associated with unconventional oil and gas activities.[18] These activities and the storage or transportation of NORMs can increase the concentrations of these substances above their natural background levels. When this occurs, they are called technologically enhanced natural occurring radioactive materials.[19]

Reserve pits of hydraulic fracturing wastes present a potentially heightened risk of exposure, such as by animals drinking pit water, wind blowing dust particles onto nearby soil and crops, and wastewater breaching the berms.

7.3.1 Drilling waste disposal

Current regulations allow a company to dispose of non-hydrocarbon-based drilling wastes on the lease site or access road, or to seek written permission to use public or private land in the area. As described in more detail below, landowners have the right to withhold their consent for many types of waste disposal methods and can influence the management of waste management on site through their surface agreements and the negotiating process.

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[16] For a review of the composition and function of drilling fluid, see Don Williamson, "Drilling Fluid Basics," *Oilfield Review* 25 (2013). http://www.slb.com/resources/oilfield_review/or_en_intro_article.aspx

[17] U.S. Environmental Protection Agency, "TENORM: Oil and Gas Production Wastes." https://www.epa.gov/radiation/tenorm-oil-and-gas-production-wastes

[18] "TENORM: Oil and Gas Production Wastes."

[19] Alisa Rich and Ernest Crosby, "Analysis of Reserve Pit Sludge From Unconventional Natural Gas Hydraulic Fracturing and Drilling Operations for the Presence of Technologically Enhanced Naturally Occurring Radioactive Material," *New Solutions,* 23 (2013).

The AER sets out its requirements for drilling waste disposal in Directive 050: Drilling Waste Management. It specifies that the company must provide landowners with a copy of the *Information for Landowners on Consent for the Disposal, Treatment, or Storage of Drilling Wastes*.[20] The directive identifies several methods for managing drilling waste:

- management on a well site or remote site — includes storage, mixed-bury-cover, landspread, disposal onto forested public lands, biodegradation, mobile thermal treatment, landspray, landspray-while-drilling, and pump-off
- management on pipeline right-of-way — includes storage, mixed-bury-cover, landspread, landspray, landspray-while-drilling, and pump-off
- management on fields and vegetated lands — includes landspray, landspray-while-drilling, and pump-off
- use of approved waste management facilities — includes landfill, waste processing biodegradation, waste cavern, and waste disposal well
- subsurface disposal of drilling waste while drilling
- alternative management methods (as approved by the AER)

Drilling waste may contain heavy metals, sodium, chloride, hydrocarbons, nitrogen or technologically enhanced NORMs, which can harm or degrade the quality of the soil. Contaminants may also migrate from disposal locations into ground or surface waters. Directive 050 therefore specifies application rates and maximum loading (including for nitrogen) for drilling waste disposal.

Companies must sample and test the wastes prior to disposal for all options. Drilling wastes are not treated before land application unless these tests indicate the presence of toxicants. If hydrocarbons are the likely source of toxicity, however, disposal may still proceed provided that all criteria for the chosen disposal method are met. Companies are also required to collect samples to assess the pre-soil conditions at the disposal site; in some cases, post-disposal soil sampling is also required.[21] Landowners should ask to see the lab results and review the disposal method criteria that the company must adhere to. If, during drilling, a company adds new substances to the mud that change its chemistry, they will have to revise their disposal plan. However, the company does not have to take into account any changes that may occur in the level of salts from the rock formations or produced water when disposal is underway.

Landowners have the right to withhold their consent for any disposal that goes beyond the well site or pipeline right-of-way boundaries for any landspray, landspray-while-drilling or pump-off

[20] The document on consent is available on the AER's landing page for *Directive 050*: https://www.aer.ca/regulations-and-compliance-enforcement/rules-and-regulations/directives/directive-050

[21] *Directive 050*, section 4.

methods, or a remote site for storage, mix-bury-cover, landspread or waste biodegradation. The company does not have to secure consent if the drilling waste will be managed on the site where it was created.[22] Off-site waste disposal requires the approval of the landowner over and above the approval given for the well site itself, or of a nearby landowner who consents to the disposal process on their land. This approval should be in writing and attached to the surface lease or right-of-entry agreement and should remain a separate agreement.

As a landowner, before giving permission for any drilling mud to be spread on your land, you should ask what type of drilling mud is being used and the level of compensation offered. If you agree to disposal on your land, ask to receive copies of the lab work on the mud sampling and the pre-disposal soil conditions, so you can ensure that the mud meets the criteria and the baseline condition of the disposal site is documented. If you are engaged in organic farming, the wastes will need to be taken off-site in order for you to maintain your organic status. Neighbours of organic farmers should also be aware that organic beekeepers can lose their organic status if sump fluids are spread within range of their hives.

7.3.2 Drilling waste treatment

There are environmentally preferable methods of treating and disposing of some wastes, particularly for invert and hydrocarbon-contaminated muds. These methods include oilfield waste treatment facilities, thermal destruction, or disposal in hazardous waste landfills. Companies should be encouraged to dispose of their waste in the way that minimizes environmental impacts.

7.3.3 Spills, leaks and contamination

You may have concerns that an oil or gas well or pipeline is contaminating soil or water. You may see a leak or spill, or it may be indicated by a change in vegetation growth. Unless it is an emergency situation, you should first ask the company to deal with the problem, although you should report the issue to the AER as well. If you are not satisfied that the problem has been adequately resolved, you will need to contact the AER again. Occasionally a leak or spill will contaminate the property of a neighbour. The owner or leaseholder of the affected land should notify the AER as soon as possible and ensure that they require the company to thoroughly clean up and remediate any affected land. If staff from the AER find evidence of spills or leaks, they can take various enforcement actions.

[22] *Directive 050*, section 1.5.

If you find a spill or leak, you should contact the AER on their Energy and Environmental 24-hour Response Line: 1-800-222-6514.

7.3.4 Land sales and contamination

Although a company is liable for any contamination that results from its activities, as the landowner you are required by law to disclose any known contamination or "latent defects" when you sell your property. A landowner can be sued for deceit or fraud if they have intentionally or recklessly misled a buyer and the buyer has been harmed as a result.

Despite this: buyer beware. Court cases have suggested that "the burden of thoroughly investigating a site remains firmly on the purchaser's shoulders."[23] Much of the time, land contracts may transfer land "as is" and exclude a warranty outside of the scope of the contract, such as the condition of the soil. Therefore, if an engineering report recommends that further investigation is necessary, or there are other indications that an investigation needs to be done, if you do not do your due diligence, the liability may fall on you as a buyer.[24] In some cases, the purchaser's bank has asked for an environmental assessment if a reclamation certificate has not been issued (section 8), and the bank may want an environmental audit before granting a mortgage. The current landowner would normally have to pay for this audit. Also, some lenders may ask for an environmental assessment of sumps or sites used for drilling waste disposal before allowing a person to use their property as security for borrowing, although this is not universally asked. These sites may or may not be identified specifically on resources like the Environmental Site Assessment Repository,[25] so you may have to dig into the approval of past projects to determine if these sites existed in the past. The Farmers' Advocate Office may be able to give advice in these situations.

[23] See *Motkoski Holdings Ltd. v. Yellowhead (County)*, 2008 ABQB 454 (CanLII). https://canlii.ca/t/1zxfk; and *Motkoski Holdings Ltd. v. Yellowhead (County)*, 2010 ABCA 72 (CanLII). https://canlii.ca/t/28dkm

[24] Rob Omura, "Fraud and Concealment of Contaminated Land: Do Your Due Diligence, Purchaser," *ABLawg,* June 2, 2010. http://ablawg.ca/2010/06/02/fraud-and-concealment-of-contaminated-land-do-your-due-diligence-purchaser/

[25] Alberta, "Environmental Site Assessment Repository." https://www.alberta.ca/environmental-site-assessment-repository

7.4 Water

Water is required for all oil and gas operations. Water is used in drilling muds and is also commonly injected into oil or gas wells to enhance production through waterflood or hydraulic fracture operations. Any operation that plans on using water must receive approval from the AER for their proposed source.

7.4.1 Water wells

Two separate issues need to be considered with respect to water wells: the effect that water wells drilled by an oil and gas company can have on groundwater, and the impacts that may be caused by oil and gas wells.

Historically, companies have drilled water wells to get water for drilling muds, but in some areas water is also used for "waterflood" operations, where it is injected into an older reservoir to enhance oil recovery. Hydraulic fracturing water use for extracting oil and gas has also exponentially grown (see section 4.1.2 for more on hydraulic fracturing). While a properly constructed oil and gas water well should not allow pollutants to reach groundwater, these wells may draw from aquifers needed to supply water for domestic and agricultural operations.

Water wells can only be drilled by someone who has a current approval from Alberta Environment and Protected Areas to drill water wells; they must follow the construction standards set out in the Water Wells and Ground Source Heat Exchange Systems Directive.[26] A company must apply for and receive a well licence from the AER only if a water well is drilled deeper than 150 m.[27] Before a company withdraws water from a water well for drilling operations, they must apply for a temporary diversion licence. Companies must obtain a term licence under the Water Act prior to any large-scale or long-term diversions of non-saline groundwater.

Hydraulic fracturing poses additional risks to groundwater, which can be contaminated in various ways, including by the upward migration of natural gas and saline water along leaky well casings, through natural fractures in the rock, from old abandoned wells, or via permeable faults. The fracturing process itself can also damage existing well casings, increasing the risk of contamination.[28] These pathways can allow fluid and gas to move over long periods, potentially causing substantial cumulative impacts on groundwater quality. To reduce this risk, the AER

[26] Alberta, *Water Wells and Ground Source Heat Exchange Systems Directive* (2018). https://open.alberta.ca/publications/9781460141588

[27] AER, *Directive 056: Energy Development Applications and Schedules* (2024), section 7.

[28] Council of Canadian Academies, *Environmental Impacts of Shale Gas Extraction in Canada* (2014), xiii. https://cca-reports.ca/reports/environmental-impacts-of-shale-gas-extraction-in-canada/

requires that for any hydraulic fracturing operations above or within 100 m below the base of groundwater protection (BGWP), a non-saline aquifer risk assessment must be done. If fractures are found to encroach on the BGWP, only fracturing fluids that pose no contamination risk to the aquifer may be used. To minimize the adverse effects on water wells, hydraulic fracturing operations cannot operate within a 200 m radius of the surface of a water well and within 100 m vertically from the final depth of the water well.[29]

Baseline water well testing

Many landowners ask the company to pay for the testing of their water well when they negotiate a lease agreement. This is to ensure that there is a baseline study against which to compare any future changes in well water quality that might result from oil- and gas-related operations. You should ensure that the lab carrying out the tests is accredited by the Canadian Association of Environmental Analytical Laboratories (see Appendix B for contact information). Be sure to ask for a copy of the test results and keep it for future reference.

The test should be thorough and cover both water volume and water quality. A basic flow test should involve pumping a well at a constant rate for at least 60 minutes, although in some cases, pumping for 120 minutes or for a day or more may be necessary. While the pumping rate is maintained, the water levels should be recorded in the well to measure the draw down. The well should then be allowed to recover for the same length of time that it was pumped, and again the depth should be measured to calculate the recovery rate of the well. In situations where the top of the well is inaccessible, it may not be possible to calculate the draw down and recovery rate, but the well should still be pumped to determine the yield. The Alberta government has a great resource regarding water wells and how to determine yield.[30]

A routine water quality test measures about ten parameters, including total dissolved solids, total hardness, alkalinity, pH, chlorides, sulphates, nitrates and nitrites, and sodium. You should ask for the test to include total extractable hydrocarbons in order to establish that there are no hydrocarbons in the water before drilling starts. A test for metals, including arsenic, cadmium, copper, lead, manganese and zinc, may also be a good idea. A test for gas content may be advisable if there is a risk of gas migration from an oil and gas operation, such as shallow coalbed methane or hydraulic fracturing operations. You can ask the company to pay for these tests and negotiate for the arrangement to be added as a condition in your surface access lease.

[29] AER, *Directive 083: Hydraulic Fracturing – Subsurface Integrity* (2024). https://www.aer.ca/regulations-and-compliance-enforcement/rules-and-regulations/directives/directive-083

[30] Alberta Agriculture and Forestry, and Alberta Environment and Parks, *Water Wells…that last: A guide for private well owners in Alberta* (2019). https://open.alberta.ca/publications/9781460143414

If a company is unwilling to pay for a routine water quality test by an independent company before it constructs an oil or gas well, you may want to ask the AER to facilitate your negotiations. While the water is being tested, you may also want to get a test done for total fecal coliforms, as these organisms can cause acute illness. However, a company may not want to pay for this part of a test, as it does not relate directly to oil and gas activities. You may want to contact the local health unit regarding bacterial tests as many health units in Alberta will cover all or part of testing costs for routine and bacterial analyses of domestic water wells.

A water quality test that includes parameters set out in the Guidelines for Canadian Drinking Water Quality, as well as other comprehensive parameters frequently required for drinking water approvals, can cost up to $2000.

Health Canada sets standards for the acceptable level of substances in drinking water.[31]

Water well drillers submit their drilling reports to the Alberta government, which are publicly available through the Alberta Water Well Information Database.[32]

Water well quality concerns

The AER handles concerns related to water well contamination suspected to be caused by oil and gas activity (see Figure 7). They will investigate if that might be the case. If you have a complaint about a water well that may be affected by the oil and gas industry, you should call the AER's Energy and Environmental 24-hour Response Line at 1-800-222-6514.

If you suspect that your well has been contaminated by hydrocarbons from oil or that gas may have leaked into the groundwater, you should get your well tested by an independent lab. All tests that were conducted before the oil or gas well was drilled should be repeated and, in addition to the test for total extractable hydrocarbons, you should also request a test for BTEX (benzene, toluene, ethylbenzene and xylenes). If you find gas in your well, a carbon isotope of each gas detected may help identify the source. You may want to negotiate with the company to arrange for them to pay for the costs of testing the well. If you need help, contact the Farmers' Advocate Office and inquire about their Water Well Restoration or Replacement Program.

[31] Health Canada, *Guidelines for Canadian Drinking Water Quality – Summary Tables* (2025). https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/water-quality/guidelines-canadian-drinking-water-quality-summary-table.html

[32] Alberta Environment and Protected Areas, "Alberta Water Well Information Database." https://www.alberta.ca/alberta-water-well-information-database

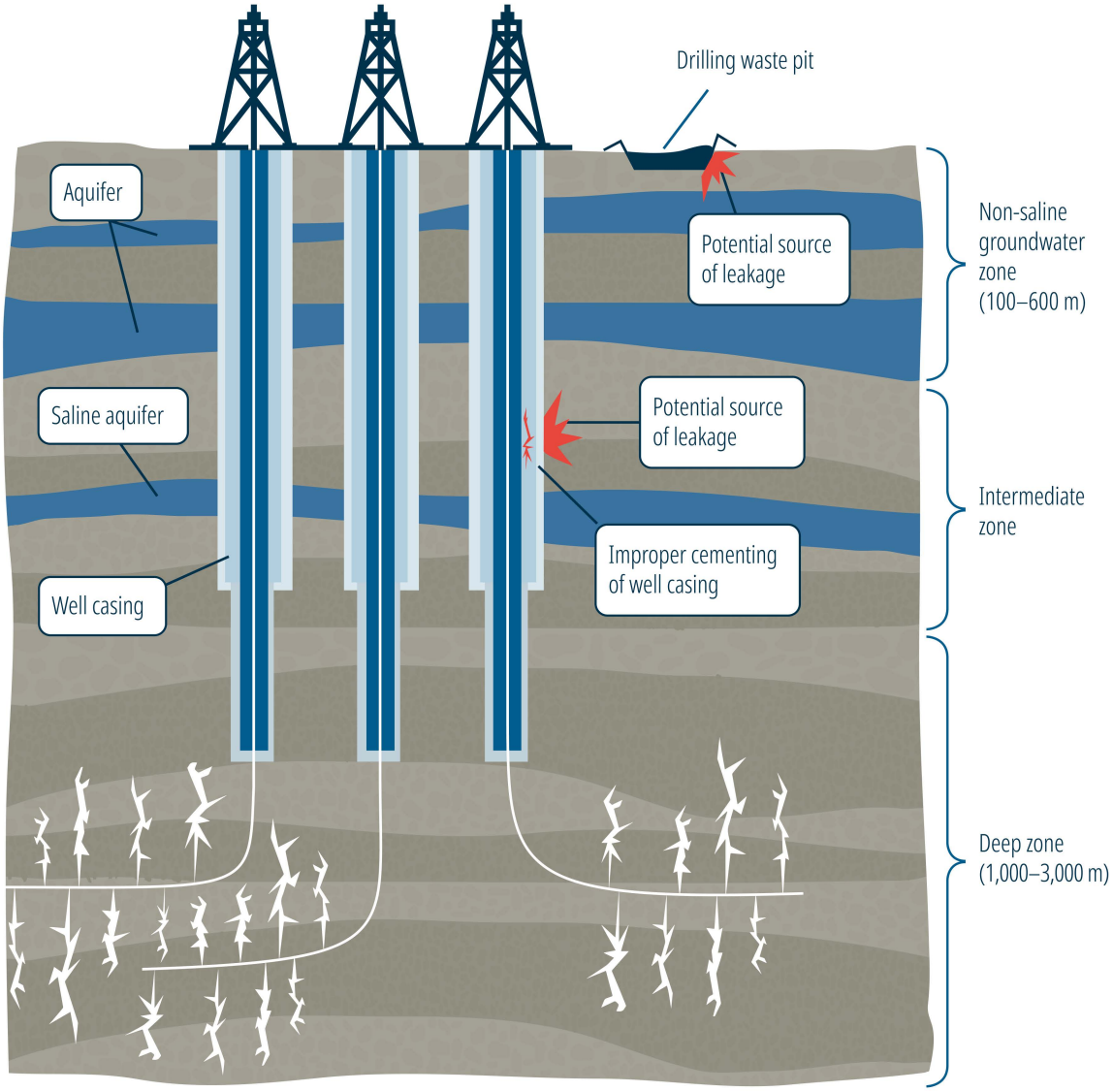

Figure 7. Schematic of well with groundwater layers and potential sources of leakage[33]

7.4.2 Surface water

Surface water can also be used to supply the necessary water at an oil and gas operation. Surface water is collected by water trucks and transported to the development site. Due to the intermittent supply, surface water is not suited for continuous operations. Instead, surface water tends to be used for drilling muds, well testing, and hydraulic fracturing, where water is only required for a temporary period.

[33] The illustration depicts an idealized geology. However, geological formations can vary greatly, causing layers that are not straight, predictable and uniform (contrary to what is shown).

If surface water is proposed to be used, the operational requirements to withdraw the water will be stipulated in an operator's water licence. It is standard for these licences to require use of a fish screen in watercourses or water bodies that contain fish populations and to limit withdrawals from watercourses to 10% of the instantaneous flow rate. These requirements ensure that fish populations and the aquatic ecosystem are not significantly affected by the water withdrawal. If a company is observed withdrawing water from a watercourse or water body on your property, they are required to show you their licence upon request. If you believe that water licence requirements are being contravened, you should notify the AER and provide any supporting evidence.

7.4.3 Coalbed methane water issues

Coalbed methane (CBM) is an unconventional natural gas formed in coal seams, also known as natural gas in coal or natural gas from coal. Coal seams can be found across the southern half of Alberta.

If a coal formation contains water, it will be necessary to remove some of the water to reduce the pressure and allow the gas to be released. In some coal seams in central Alberta (for example, those in the Horseshoe Canyon Formation), the coal is "dry" and no dewatering is necessary; however, deep coal formations (such as those in the Mannville Group) usually contain saline groundwater.[34] This water will usually be pumped out and piped to a central injection well, where it will be re-injected deep underground, in the same way that saline water from a conventional natural gas well is re-injected. If the saline zone is closely below the non-saline zone, a company should not produce any gas from the non-saline zone since this could result in the mixing of water of different qualities.

An operator of coalbed methane wells must conduct baseline water testing for a new well or for completing or recompleting wells if the wells are shallow and above the BGWP.[35] Since these wells are being drilled into shallow non-saline aquifers, which require dewatering to release the gas, their operations have the potential to impact the flow of water to other water wells.

[34] Saline groundwater is defined as water with more than 4,000 milligrams per litre of total dissolved solids (Alberta, *Water (Ministerial) Regulation*, 205/98, s. 1(1)(z)). The depth at which water becomes saline varies widely, but the transition may occur between 400–600 m in Alberta.

[35] The base of groundwater protection is the term the AER uses for the approximate depth at which non-saline groundwater changes to saline, plus a standard depth buffer. AER, *Frequently Asked Questions: Base of Groundwater Protection* (2016). https://static.aer.ca/prd/documents/dds/BGWP_FAQs.pdf

A conventional oil or gas well will sometimes produce saline water, with the quantity likely to increase as the well ages. This water is pumped out with the oil or gas, separated and injected back deep underground. If a CBM well contains water, it will need dewatering at the start of operations so that the gas can be released.

You should get your water wells tested before any CBM development takes place within a nearby shallow, non-saline aquifer. The AER requires that developers offer to test the nearest water well or observation well within a 600 m radius of the proposed CBM well.[36] Companies are required to provide detailed reports before the AER will consider an application for the diversion of groundwater. This is because dewatering of the coal seams could lower the water level in domestic wells if the coal is near the surface or there is hydraulic connectivity with shallow aquifers. This data provides a baseline against which to measure any future changes.

If, after drilling, a company finds they need to divert non-saline water from the coal seam, they must submit a technical report to the AER together with their application. The technical report must include detailed information about the hydrogeology, aquifers and water wells.

The AER administers water standards that require a company to test water wells for gas and, if gas is detected, to test for the carbon isotopes of each gas.[37] This will help identify the source of any gas and serve as a baseline in case the CBM development leads to gas migration in the future. The AER also publishes a public notice about the proposed water withdrawal and must respond to any statements of concern from the public. The regulator is required to consider all statements from those who are directly and adversely affected before deciding on whether to authorize the diversion of water from the aquifer.

If a CBM well is drilled into a non-saline aquifer, you should ask about plans to dewater the coal seams, any potential impacts on groundwater, and how the water will be handled.

While saline water must be re-injected deep underground, there are different ways that non-saline water can be handled. If the AER issues a licence or approval for diversion of non-saline water, it will indicate how the water must be handled. Even water that is defined as non-saline must be managed carefully since the level of salts may be sufficient to damage soils and crops. Depending on the salt content, non-saline water that exceeds potable-water standards for dissolved salts could potentially be used for watering livestock. Whether the water is suitable for

[36] Under *Directive 035*, if there is no well within 600 m, the operator is required to offer to test the nearest water well or observation well within 800 m.

[37] AER, *Gas Sampling Requirements for Baseline Water-Well Testing for Coalbed Methane/Natural Gas in Coal Operations* (2014). https://static.aer.ca/prd/documents/applications/WA_StandardBaselineWater-WellTestingCoal.pdf

irrigation will depend not only on the salt content and the crops grown, but also on the sodium adsorption ratio of the receiving soil. Alternatively, the water may be discharged or re-injected into a compatible aquifer underground. Since the quality of the water may change during the dewatering process, regular testing of the salinity level should be requested.

While requirements are designed to prevent damage to a non-saline aquifer, it is advisable to ensure that the company will provide an alternative water supply should your water well be adversely affected by CBM drilling. You should include a clause to this effect in your surface lease agreement.

Licences issued by the AER for groundwater diversions typically include "investigation and mitigation" requirements that may include alternative water supply arrangements if needed. You typically would need to provide a written complaint to the AER to start an investigation.

7.5 Noise

Compressor stations, processing plants, well batteries, well drilling and servicing operations can all cause noise, which is especially noticeable in quiet rural areas. If you have a complaint, you should first contact the company, but if you have a problem locating the company or if you are not satisfied with their response, contact the AER 24-hour emergency and operational complaint number, 1-800-222-6514, and ask them to help.

Noise is measured in decibels, which is a logarithmic scale; an increase in ten decibels is perceived as a doubling in noise level. Examples of the sound levels of familiar noises are given in Table 6.

The AER policy on noise is summarized in Directive 038: Noise Control. This directive also sets out noise requirements for all facilities approved by the AER, including drilling and service rigs. The directive aims to keep sound levels to an acceptable minimum so that the quality of life for neighbours of a facility is not impaired and their sleep is not affected. The directive regards noise from the "receptor viewpoint" rather than considering sound levels at the property line.

Table 6. Examples of noise levels

Source	Sound level (dBA[38])
Soft whisper at 1.5 m	30
Quiet office or living room AER target nighttime sound level at low-density housing with dwellings more than 500 m from heavily travelled roads[39]	40
Inside average urban home, quiet street, refrigerator	50
Noisy office, conversation at 1 m	60
Highway traffic at 15 m	75
Jackhammer	88–98
Loud shout	90
Modified motorcycle	95
Amplified rock music	110

A person can make a complaint about noise in different ways — in person or by phone, fax, email or letter. Once the company has been informed, it must contact the complainant directly to try to understand the concerns and work out reasonable expectations and a time frame for action. Section 2 of Directive 038 sets out what the AER considers permissible sound levels. Section 4 provides more detail about dealing with complaints, and the AER Forms webpage under "Directive 038" contains a noise complaint investigation form that the company and the complainant will need to complete.[40] If a company conducts a sound survey, it must ensure that it is carried out under representative conditions that would affect the person complaining.

A noise impact assessment is required for a new facility or for modifications to an existing facility in order to identify and deal with aspects that might later cause problems. For these facilities, a company commits to the AER in its application[41] to comply with the noise requirements in Directive 038.

[38] As explained in AER *Directive 038*, Appendix 2, sound is measured in decibels. However, to better approximate how people hear, given that sensitivity varies across different frequency ranges, sound measurements are adjusted using the A-weighted decibel scale, and the results are expressed as dBA. The AER uses dBA Leq measurements, which represent energy equivalent sound levels.

[39] AER, *Directive 038*, Table 1.

[40] AER, "Directive Forms," Directive 038. https://www.aer.ca/applications-and-notices/application-processes/aer-forms/directive-forms#d38

[41] AER, *Directive 056*.

Although Directive 038 does not cover construction, the AER expects construction companies to keep noise to acceptable levels and take reasonable mitigating measures, such as only undertaking noisy operations between 7 a.m. and 10 p.m. The AER also asks operators to advise nearby residents of noise-causing activities and to schedule them to cause the least disruption.[42]

7.6 Conservation and reclamation

A company is required by law to pay attention to conservation and to minimize damage to the environment during the development and operation of an oil or gas well. The Government of Alberta sets criteria for soil conditions for reclamation, but you may want to discuss issues relating to your specific site.[43]

7.6.1 Pre-development

Landowners should discuss and outline in an agreement with the company how the company will preserve topsoil so that it can be used later to help restore the site. It is important that the topsoil be stripped and stored carefully; it must not be used for the construction of berms or dikes. It may also be advisable to have a layer of subsoil under roads and well sites stripped and stored separately, since years of compaction can cause permanent damage to the soil structure. In some situations, it may be advisable to ask that an elevation survey of the site be completed along with the basic survey to ensure that the surface of the land is later restored to the same elevation and that drainage is not affected.

Paying attention to the way in which a company deals with its drilling wastes may also prevent problems when the site is eventually closed and the leased land reverts back to the landowner. As remote sumps and disposal sites are often difficult to identify, a landowner should require the company to clearly identify their locations in the surface lease agreement. This ensures that when a site is abandoned, the company can reclaim any area where disposal or remote sumps were located prior to applying to the AER for a reclamation certificate.

After the lease is signed, but before the company starts operations, a pre-construction site assessment report should be completed and provided to the landowner. This report provides a

[42] AER, *Directive 038*.

[43] On its webpage "Reclamation Process and Criteria for Oil and Gas Sites," the AER lists the most pertinent documents that contain reclamation criteria for well sites and associated facilities." https://www.aer.ca/regulations-and-compliance-enforcement/site-closure-requirements/reclamation/oil-and-gas-sites/reclamation-process-and-criteria-oil-and-gas-sites

baseline against which to measure any future changes. The Alberta government provides examples of what should be included in this report.[44]

In areas of native pasture and parkland, a company should avoid or minimize its impacts on native vegetation.[45]

7.6.2 Post-development

Problems can arise during work to abandon and reclaim a well site. The AER is responsible for down-hole well closure, and in 2014 assumed responsibility for regulating reclamation and remediation activities from oil, gas, and coal operations. Complaints about surface reclamation on both public and private lands should be made to the AER 24-hour Energy and Environmental Emergency 24-hour Response Line, 1-800-222-6514.

The process for reclamation is explained in section 8. The fact that a reclamation certificate has been issued does not guarantee that work has been done well, as problems may not become evident until later. At the time of writing, a company is responsible for 25 years for surface reclamation issues such as vegetation, soil texture, and drainage; and it has a lifetime liability for contamination.[46] If landowners or occupants have problems with the reclaimed land, they should contact the company first and then notify the AER. An AER inspector may inspect the site and may require the company to conduct further work in response to the notification.

7.7 Animal health

Problems can arise if animals eat contaminated vegetation or come into contact with contaminated soil, or spills such as oil, condensate, or hydraulic fracturing fluids. Animals may also be affected by air emissions. If you believe that oil or gas activity may have an impact on your livestock, you can negotiate for precautionary commitments to be added to your surface lease agreement such as fencing to ensure your animals don't come into close contact with the well site. Landowners concerned about the impact that air pollution might have on their animals

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[44] Alberta, *Conservation and Reclamation Information Letter*: *Pre-construction Assessment Report for Wellsites,* C&R/IL/00-8 (2000). https://open.alberta.ca/publications/pre-construction-assessment-report-for-wellsites. This information letter indicates that the assessment should include a description of the land use, the type of surface soil salvage, the average depth of surface soil, the location of salvaged stockpiles, and drainage. It should detail any evidence of erosion or salinity, areas with poor vegetation, and weed patches, and ideally would include photographs. You may want to take your own photographs of the site before work starts to augment the information provided in the pre-construction assessment report in case there is any later damage that is not satisfactorily reclaimed.

[45] AER, *Manual 007: Principles for Minimizing Surface Disturbance in Native Prairie and Parkland Areas* (2014). https://static.aer.ca/prd/documents/manuals/Manual007.pdf

[46] AER, *Closure – Abandonment, Reclamation, and Remediation Fact Sheet* (2025). https://static.aer.ca/prd/documents/enerfaqs/Closure_FS.pdf

should request assessments of the project's emissions and the location of where they are released in relation to active pasture lands. You can also include clauses in your agreement that cover the costs of a necropsy in cases where you suspect nearby development may have played a role in an animal death. It would be helpful to have an ongoing relationship with a veterinarian to establish a herd health baseline, enabling you to monitor changes in health and behaviour compared to conditions before development.

If you think that oil or gas activity is affecting the health of your livestock, contact your local veterinarian and the AER's 24-hour emergency number at 1-800-222-6514. An independent animal health investigator may be called in. Be sure to keep a record of events and take photographs to aid any investigation.

7.8 Earthquakes

A number of earthquakes (also known as seismic events), including in Alberta, have been linked to wastewater disposal and hydraulic fracturing operations, which increase pressure in the subsurface.

Starting in 2013, the Alberta Geological Survey measured unexpected and persistent patterns of earthquakes west of the community of Fox Creek. By comparing the timing of the events with local operations, the earthquakes were determined to be associated with hydraulic fracturing.[47] As these operations continued and earthquake activity intensified, the AER issued Subsurface Order No. 2 in 2015 to establish new seismic monitoring and reporting requirements for hydraulic fracturing operations only in the Fox Creek area.[48] This order requires operators to monitor earthquake activity within 5 km of their wells and to develop response plans to address potential seismic events. If an operator measures an earthquake greater than 2.0 local magnitude (M_L), they must report the event to the AER. If an operator measures an event greater than 4.0 M_L, they are required to immediately cease operations. Operations are not allowed to recommence until AER approval is received.

[47] Gail M. Atkinson et al., "Hydraulic Fracturing and Seismicity in the Western Canada Sedimentary Basin," *Seismological Research Letters* 87 (2016). https://doi.org/10.1785/0220150263

[48] AER, *Bulletin 2015-07: Subsurface Order No. 2: Monitoring and Reporting of Seismicity in the Vicinity of Hydraulic Fracturing Operations in the Duvernay Zone, Fox Creek, Alberta*, February 2015. http://www.aer.ca/documents/bulletins/Bulletin-2015-07.pdf

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