PEMBINA institute

Landowners' Guide to Oil and Gas Development

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Section 4

Oil and Gas Wells

photo: Roberta Franchuk, Pembina Institute

4. Oil and Gas Wells

As an oil and gas well is a long-term project, it is important to understand the details and process of drilling for oil and gas in Alberta so that you know your rights when it comes time to sign a lease on your land. Although the company is required to provide some information when they approach you to negotiate a surface access agreement, this chapter contains additional questions and information that you should consider carefully before you sign your name. If your well will contain sour gas (hydrogen sulphide, or H_2S), the company must meet additional requirements, which are summarized in this chapter as well. Finally, this chapter examines specific issues that you need to consider with respect to the construction and operation of hydraulic fracturing wells, a relatively newer form of oil and gas production in Alberta. While hydraulic fracturing uses similar equipment as other conventional oil and gas wells, the operations are generally more intensive and come with some unique considerations for maintaining your property and protecting the surrounding environment.

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> Each year the Alberta Energy Regulator receives more than 47,000 applications related to oil and gas operations.[1]

4.1 Overview of oil and gas wells

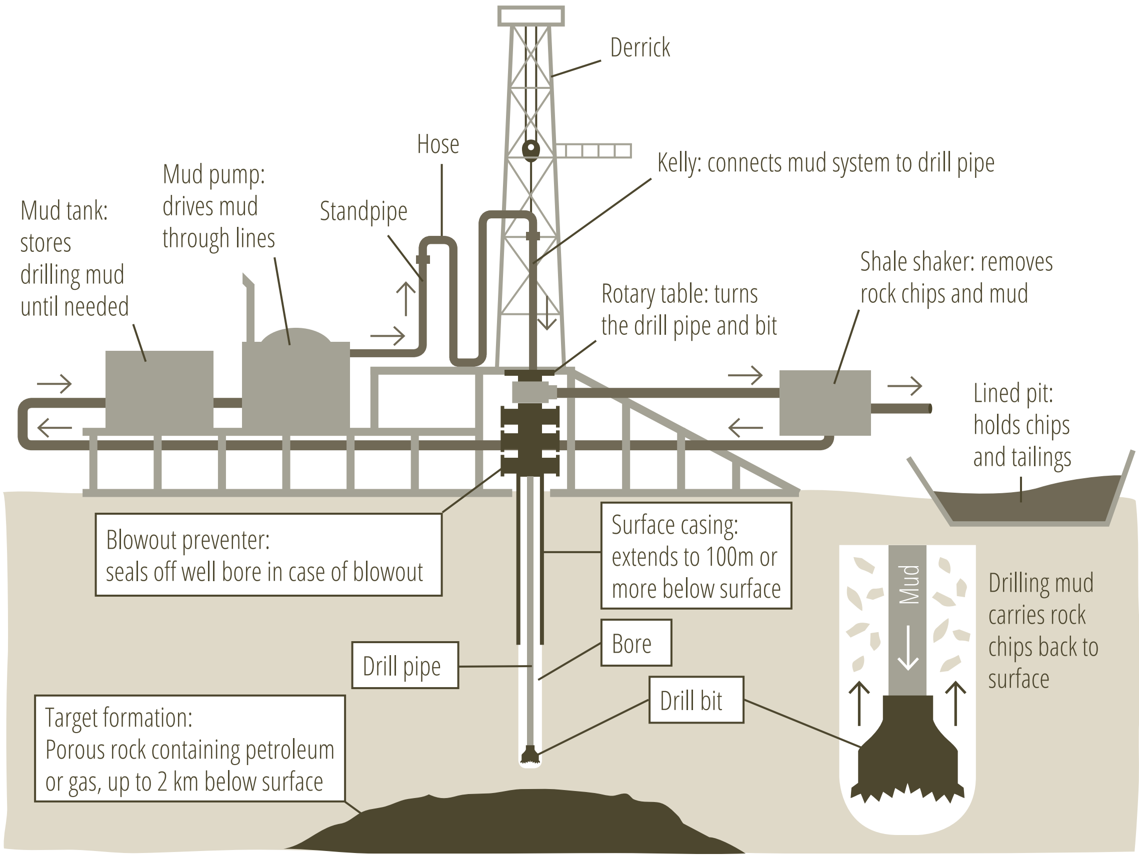

Figure 3. Schematic of typical drilling rig

4.1.1 Application for development

If a company has discovered a prospect of oil or gas, they will lease the mineral rights for development of that resource from Alberta Energy or from *freehold mineral rights* owners. Before they can actually develop the oil or gas, the company must submit a resource application to the Alberta Energy Regulator (AER). The AER needs to ensure

[1] AER, *2015/16 Annual Report*, 47. https://www.aer.ca/data-and-publications/publications/aer-annual-report

that the company's plans optimize the extraction of the oil or gas but don't interfere with other companies that have adjacent mineral rights.

4.1.2 Well spacing

Traditionally, standard surface well spacing is one well per section (640 acres) for gas wells and one well per quarter section (160 acres) for oil wells.[2] *Shale gas* and *coalbed methane* wells are exempt from traditional spacing requirements, so well activity will likely be much denser.[3] A company that uses *horizontal* fracturing may apply to the AER for a higher surface well density and use one pad for multiple wells *drilled* horizontally in different directions. Spacing units are described in AER's Understanding Oil and Gas Development in Alberta,[4] which a company is required to give each *landowner* affected.[5] Applying for reduced spacing units and directional drilling is now a common practice in Alberta, so it may be common in your area,[6] and take the form of multi-well pads.

A company is not required by the AER to notify landowners and *occupants* if it wants to use higher well density than is the AER norm, but they may do so if the project is contentious.[7] If you have concerns about an application for special well spacing, you can notify the company of your concerns and submit a *statement of concern* (Section 2.5), which would result in the application being considered *non-routine*.[8] However, objections to well spacing by a *resident* or landowner will likely have to be addressed in the *negotiation* process for the project as a whole (see Section 2.2), through an the *Alternative Dispute Resolution* process (Section 2.4.1) or a public *hearing* (Section 11). If the company and landowners/occupants are unable to agree on the closer well spacing

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[2] AER, Directive 056: Energy Development Applications and Schedules (2014), A-44. AER Directives are available at AER, "Directives." http://www.aer.ca/rules-and-regulations/directives/

[3] AER, Bulletin 2011-29: Changes to the Province-Wide Framework for Well Spacing for Conventional and Unconventional Oil and Gas Reservoirs. (October 6, 2011). http://www.aer.ca/rules-and-regulations/bulletins/bulletin-2011-29

[4] AER, Directive 056, A-44.

[5] AER, Directive 056, section 2.2.2.

[6] AER, Directive 056, A-44.

[7] AER, Directive 065: Resource Applications for Conventional Oil and Gas Reservoirs (2010), section 7-11.

[8] AER, "Non-routine Public Involvement Authorizations." https://www.aer.ca/applications-and-notices/application-process/non-routine-public-involvement-authorizations.htm

during the negotiation process, the company must report this to the AER when filing the resource application.

> The AER has developed an Alternative Dispute Resolution (ADR) program which helps resolve issues and disputes between *stakeholders*. Any stakeholder involved in an energy dispute may contact the ADR team at any time for information and assistance. The ADR team will assist in arranging the logistics of a dispute-resolution meeting and will help with the preparation and facilitation of different options including direct negotiation, AER staff *mediation*, third-party mediation, and *arbitration*.[9] More information about the ADR process is found in Section 2.4.1.

4.1.3 Disposal wells and CO_2 storage

While this section is primarily concerned with oil and gas wells, it is appropriate to note here the AER process for regulating disposal wells. AER Directive 065 includes notification requirements if a company wants to drill a well to dispose of oilfield or industrial waste. Landowners and occupants within 0.5 km of the proposed disposal well are to be notified,[10] and the company has to check that they do not have any outstanding concerns. If a company is applying for approval for the underground disposal of *acid gas* or underground gas storage, the public will be notified if it contains any *hydrogen sulphide* (H_2S) through the distribution of an emergency response plan (Section 4.6.1).

AER Directive 065 also regulates the use of carbon dioxide (CO_2) for *enhanced oil recovery* or underground storage. In the near future, CO_2 will most likely be primarily used for enhanced oil recovery, replacing some of the water currently used to maintain the pressure in depleted reservoirs. In the future there may be an increase in *carbon capture and storage* (CCS) operations, where CO_2 is captured and stored underground solely to reduce releases of this greenhouse gas to the atmosphere.

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[9] AER, *EnerFAQs: All About Alternative Dispute Resolution (ADR)* (2015). EnerFAQs and Fact Sheets are available at AER, "EnerFAQs (Q&As)" http://www.aer.ca/about-aer/enerfaqs

[10] AER, Directive 065, section 21.

4.2 Surveying

Before a company decides exactly where to drill a well, they may send in surveyors to find the best location for the well and access roads.

As a way to have the right information and establish a professional relationship with the surveryors it is a good approach to get the name of the responsible surveyor — they have ultimate authority for survey activities on your land. If issues arise with the surveying it is advisable to first talk with the responsible surveyor; if issues are not resolved, you may wish to file a formal complaint against the responsible surveyor with the Alberta Land Surveyors' Association.[11]

The Surveys Act[12] and the Surface Rights Act[13] allow a registered land surveyor to enter and conduct surveys on private land without prior consent,[14] but the surveyor or the company that engages the surveyor is liable for any damage that the survey team may cause. The Alberta Land Surveyors' Association strongly encourages its members to contact landowners prior to coming onto a property and, in the event that a landowner is not home, to leave a card that a survey crew has been on the property. If entry for a surveyor is refused, the company can apply for a court order to gain access.

If you are a landowner/occupant with livestock, you may want to negotiate moving them from the area to be surveyed. It is advisable to check the area after the surveying has been completed to check for damages, and ensure that nothing has been left behind that could harm the animals.

4.3 The land agent calls

Before a company can apply to the AER to drill a well on private land or leased *public land*, they must send a *land agent* to consult with landowners, occupants and others

[11] See Section B.2.2. for information about the Alberta Land Surveyors' Association and their formal complaints procedure.

[12] Alberta, Surveys Act, RSA 2000, c S-26, s 16. Alberta government acts are available at Alberta Queen's Printer, "Laws Online/Catalogue." http://www.qp.alberta.ca/Laws_Online.cfm

[13] Alberta, Surface Rights Act, RSA 2000, c S-24, s 14.

[14] The Surface Rights Act requires surveyors make a reasonable attempt to give notice, but allows for surveyors to enter land if that they were not able to contact the landowner.

whose rights may be affected by their projects[15,16] to request their consent as required under the AER's Directive 056.[17,18] If consent is refused after the company has attempted to negotiate, once the company has received a licence from the AER they can apply for a *right-of-entry* order from the Surface Rights Board, as explained in Section 10.3.1. As indicated in Section 10.3.2, the landowner may also find it beneficial to have the company obtain a right-of-entry order. The company may also have to consult with or notify those living on neighbouring properties, depending on the distance of the property from the well and the type of well being drilled (see Section 2.1).

The minimum distances within which people must be consulted or notified for a new project application are set out in the AER Directive 056: Energy Development Applications and Schedules, and are broken down in Section 2.1.1. The directive has specific requirements not only for wells, but also for pipelines and facilities, such as *compressor* stations, *batteries* and *gas plants*. These are discussed in later chapters of this guide, but the initial meeting with the land agent will be similar in each case. While the directive sets the minimum consultation and notification requirements, the land agent must also assess the area and decide if other people (e.g., those living just outside the minimum distance requirements) could be impacted, and thus should be contacted before the company files its application with the AER.

Information you should receive

Where the AER requires consultation, the land agent must deliver both the company's public information package and information from the AER.[19] The company's package should describe not only the type of project (e.g., the specific category of well, as

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[15] For more information on land agents, see Section A.7, or Alberta Labour, *Surface Rights and the Land Agent: A Guide for Landowners and Occupants Concerning Land Agents and Surface Rights Agencies*. https://work.alberta.ca/documents/surface-rights-and-the-land-agent.pdf Although the document is slightly dated, it still contains good information.

[16] The Alberta Association of Surface Land Agents is described in Section B.2.1 and the Canadian Association of Petroleum Landmen in Section B.2.5.The main professional organizations that represent the oil and gas companies are the Canadian Association of Petroleum Producers (Section B.2.6) and the Explorers and Producers Association of Canada (Section B.2.10).

[17] Surface Rights Act, section 12(1). The AER will accept documented verbal non-objection; the Regulator does not necessarily require written consent.

[18] AER, Directive 056.

[19] A full list of the information that a company must disclose can be found in AER, Directive 056, section 2.2.2

defined in Directive 056) and its location, but also whether any gas will contain H_2S. It must include information on *setback* distances, *flaring*, potential noise and traffic impacts, as well as the *emergency planning zone*, where relevant. The company is also required to reveal how the proposed development will fit in with its existing and future plans and discuss how setbacks might impact your future land use.

> Read the information package very carefully—both the company's information on the project and the AER documents that explain the input you can have in the process.

The AER documents include:[20]

- a letter from the CEO of the AER, describing the AER public information documents, the company's information package and the dispute resolution process, as well as listing the contact numbers for the AER regional offices
- AER brochure, *Understanding Oil and Gas Development in Alberta*
- *EnerFAQs: Proposed Oil and Gas Wells, Pipelines and Facilities — A Landowner's Guide*
- *Expressing Your Concerns – How to File a Statement of Concern About an Energy Resource Project*

The company must also offer all current AER EnerFAQs publications that relate to the type of energy development, which might include:

- *All About Critical Sour Wells*
- *Explaining AER Setbacks*
- *Flaring and Incineration*
- *The AER and You: Agreements, Commitments, and Conditions*

Other EnerFAQs are listed in Section A.2.6; all can be found on the AER website.

This information will provide the basis for consultation with the landowner/occupant. Although actual developments may depend on the information gained from a new well, it is still a good idea to ask the company about their future plans.

[20] AER, Directive 056. Appendix 10 contains the letter and the brochure. Appendix 11 Understanding the Participant Involvement (PI) Process tells industry how the AER expects a company to inform and consult with the public. Section 2 gives the general requirements for participant involvement.

Remember, that if the well contains *sour gas*, the setback distances may be greater than for *sweet gas*; it will not be possible to use the land within the setback distance for residences and buildings until after the well is abandoned.

> Section 5 deals with issues relating to pipelines and Section 6 covers oil batteries, compressors, and dehydrators.

Time to respond

It is a good idea to talk to your neighbours to find out about other companies operating in the local area and to inquire about their plans, thus giving you a fuller scope of expected development. Before companies file their application with the Regulator, companies must send out notification of their proposed development, and then allow the public in the participant involvement program (or others who have expressed concern) at least 14 calendar days to consider and respond to the notice. If a company receives confirmation of *non-objection* from all those who must be notified before the 14-day period has ended, they may file their application earlier.[21] If after 14 days the company has not resolved all of the objections, they may file the application with the AER but must indicate that there are outstanding objections. This 14-day period is part of the participant involvement program, laid out in Directive 056. If all issues and concerns are resolved by the company before they file an application, they are entitled to file a *routine application*, which may allow for an *expedited* approval process (such as the Regulator making a decision before the filing period for a statement of concern is over). If there are outstanding concerns, the company must file a non-routine application, and there will likely be the full 30-day time period to file a statement of concern.

> The requirements for companies regarding public consultation and notification are discussed in Section 2.1.

The following sections identify some issues you may want to discuss with the land agent, such as site selection, setbacks and various environmental considerations. These issues are summarized in a series of questions in Section 4.5. If you are unable to resolve issues relating to site selection, the terms of the proposed lease or any other health, safety, environmental, or socio-economic issue (except compensation), the

[21] AER, Directive 056, section 2.3.2.

company may propose using the AER's Alternative Dispute Resolution (Section 2.4.1) process to facilitate or mediate an agreement (Section 2.2). Any issues relating to compensation are dealt with by the Surface Rights Board (Section 10).

4.4 Site selection and setbacks

The land agent will show you on a survey plan where the company wants to drill the well. If you feel that the site they have chosen is problematic, explain why this is the case and ask them to evaluate alternative sites. The company may be able to change the surface location of a well without affecting their chances of finding oil or gas.

Ask the company to locate the well as far away as possible from your residence, buildings, and water wells, to minimize the impact on you and your family. Keep in mind the prevailing winds between your house and the well, as there may be flaring activity during the drilling period of the project.

An oil or gas well is not usually permitted within 100 metres of a dwelling, permanent farm building, school or *surface water* body, or within 40 metres of a surveyed road.[22] The setback depends in part on the nature of the well, with greater distances required for sour gas wells than for oil wells and sweet gas wells. Check that the location of any water wells is shown on the survey plan and that the setback distances are satisfactory. Information on setbacks is provided in AER *EnerFAQs: Explaining AER Setbacks*.[23]

The minimum setback distances for sour gas facilities are shown in Table 3. The setbacks for sweet gas wells are the same as for a Level 1 sour gas facility.[24] As a landowner, you may want to negotiate a larger setback in some circumstances.

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[22] Alberta, Oil and Gas Conservation Rules, 151/1971, section 2.110 (Alberta government regulations are available at Alberta Queen's Printer, "Laws Online/Catalogue." http://www.qp.alberta.ca/Laws_Online.cfm); see also AER, Directive 056, section 5.9.10.

[23] AER, *EnerFAQs: Explaining AER Setbacks* (2014).

[24] Oil and Gas Conservation Rules, section 2.110; see also AER, Directive 056, table 7.5.

Table 3. Setback requirements for sour gas wells

Level of facility	H_2S release rate (m^3/s)	Minimum distance
1	<0.3	At least 100 m to a surface improvement (e.g. dwelling, permanent farm building, school or church)
2	0.3–2.0	At least 100 m to individual permanent dwellings and *unrestricted country development*[25] At least 500 m to *urban centres* or public facilities
3	2.0–6.0	At least 100 m to individual permanent dwellings up to 8 dwellings per quarter section At least 500 m to unrestricted country developments At least 1.5 km to urban centres or public facilities
4	> 6.0	As specified by the AER, but not less than Level 3

Source: This table is based on information in AER Directive 056: Energy Development Applications and Schedules, Tables 5.5, 6.3 and 7.5[26] Refer to these tables for full details.

Note: Any well classified as a Level 1, 2, 3, or 4 sour well may also be classified as a *critical sour well*[27], which means there are stringent safety requirements, including an emergency response plan.

Further information on sour gas is provided in Section 4.6. For setback requirements for pipelines, see Table 4, and for batteries, gas compressors and other facilities, see Table 5.

[25] Unrestricted country developments refer to any collection of permanent dwellings outside an urban centre that number more than eight per quarter section.

[26] The AER refers to Category D pipelines (where the pipeline associated with the facility contains gas with more than 10 mol/kmol H_2S), and Category C, D or E facilities, which are classified according to the volume of sulphur inlet to the facility. This includes gas processing plants, some gas and oil batteries and *straddle plants*, etc. Facilities with less than 0.01 mol/kmol H_2S in the inlet stream are in Category B and thus exempt. See AER Directive 056, table 5.1 for full description of categories. The AER provides a H_2S Conversion Calculator on their website: http://www.aer.ca/rules-and-regulations/directives/directive-056

[27] AER, *EnerFAQs: All About Critical Sour Wells* (2015)

4.5 Questions to ask before signing a well lease agreement

Besides the physical aspects of a well, there are also financial considerations. Before signing a lease, you will also want to read Section 2 and Section 10. Some landowners prefer to request a right-of-entry order from the Surface Rights Board rather than signing a surface lease agreement with the company, even though they have reached agreement on all issues and on the amount of compensation. More information on right-of-entry orders when there is agreement, and the associated consent compensation order, is given in Section 10.3.2.

The AER provides a detailed list of "Questions you may want to use for discussion between you and a company" in *EnerFAQs: Proposed Oil and Gas Wells, Pipelines, and Facilities: A Landowner's Guide*.[28]

The following list of questions identifies additional issues, especially with respect to environmental impacts, that you may want to discuss with the land agent before you sign a lease agreement. If you negotiate any special conditions that the company must meet, ensure that they are added in writing to the lease agreement.

> Section 6.2 provides information on compressors, which are sometimes located on the well site. These may be needed when the well is built or later. They may also be centrally located to serve multiple wells. Some of these facilities may have long term impacts on you and your family, so make sure to review the questions at the end of Section 6 if they apply to you.
>
> Section 8, which addresses potential impacts during the operation of oil and gas wells, may help you identify additional issues that are relevant to your situation.

Legal

> **Have you read the Letter from the AER Chairman and AER brochure Understanding Oil and Gas Development in Alberta, *EnerFAQs: Proposed Oil and Gas Development: A Landowner's Guide* and other relevant AER FAQs?**

[28] AER, *EnerFAQs: Proposed Oil and Gas Wells, Pipelines, and Facilities: A Landowner's Guide* (2015), 9.

The company's land agent will have given you or offered you these documents together with the company's information package and the outline surface lease agreement.

Have you read Negotiating Surface Rights?

This publication from the Farmers' Advocate Office is available online[29] *or by calling their office.*

Have you agreed how you want to settle any future issues?

Decide if you want to stipulate that the alternative dispute resolution process should be used as a first step. Ensure the agreement contains an arbitration clause that enables unresolved disputes to be settled under the Alberta Arbitration Act, without going to court.

Have you read about compensation in Section 10 of this guide?

It is important to negotiate and agree on compensation before signing the lease agreement.

Do you need to negotiate special compensation for any damage to special livestock?

If you have valuable purebred animals or breeding stock, you may want to negotiate a replacement value that is greater than the commercial value of ordinary livestock.

Is the arbitration clause in the agreement satisfactory?

You may want to negotiate that the company will pay the costs of arbitration.

Do you want to request a right-of-entry order from the Surface Rights Board rather than signing a lease?

Some landowners prefer to request a right-of-entry order from the Surface Rights Board, rather than sign a lease agreement, even if they have reached agreement with the company on all issues, including compensation. See Section 10.3.2.

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[29] Alberta Agriculture and Forestry, *Negotiating Surface Rights* (2009) Agdex 878-1. http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex1126?opendocument

Have you taken the time to read through the agreement carefully, to ensure that all the clauses are satisfactory? Is everything that you have negotiated with the company included in the written agreement?

The Office of the Farmers' Advocate can provide advice on wording clauses, if you need an addendum (See Section A.4 for more information about the Farmers' Advocate Office).

Do you need to check with a lawyer/consultant before signing the lease agreement to ensure that it meets your needs?

A lawyer or consultant who is knowledgeable about surface rights issues may help in negotiations. It can also be helpful to discuss issues with an experienced neighbour or landowner group.

Well type and location

Are you satisfied with the location of the well and access road?

Are the well and access road located to minimize inconvenience to you or your neighbours while still ensuring the company's ability to protect the environment? Is the well at least the minimum distance from buildings, water wells, etc.?

What type of well is being drilled?

If it is a sour gas well, read Section 4.6.

If it is a shale gas, tight oil *or coalbed methane well, read Section 4.7.*

Water

Is your water supply protected?

Ensure that the oil or gas well is far enough from your water well and other water bodies. Ask the company to test all water wells near the lease for depth, volume and water quality, both before and after drilling. Ensure the water samples are analyzed by a laboratory accredited for those specific tests by the Canadian Association of Environmental Analytical Laboratories and that you receive a copy of the results.

Does the company want to drill a water well on site to supply water while drilling?

A water well must be drilled according to AER requirements and be properly abandoned when no longer required.

How will surface water be managed on the lease site?

The company should ensure that off-site surface waters will not enter into the drilling area. On-site waters should be captured in a containment pond and disposed of with the drilling muds or tested prior to release off-site. You may want to include a clause in the lease agreement that notes the direction of drainage and requires the company to maintain natural drainage and install culverts or other works to ensure this.

Land

How will topsoil be protected?

Find out how the topsoil will be conserved so that it can be used for reclaiming *the site when the well is shut down, and where it will be stored. Ask if the* subsoil *will also be stripped and stored for use in reclamation (called "two-lift salvage"). Make sure that the company is not allowed to use coarse gravel or rock on the leased land unless this can be removed when the land is reclaimed.*

How will weeds be controlled?

Decide if you want equipment to be steam-cleaned to remove weed seeds before entering your property,[30] *and if you want weeds on the site to be controlled by mowing rather than with herbicides. You may want to ask the company to obtain consent before using any chemical, soil sterilants, pesticides or herbicides on your land.*

Is the clause in the lease agreement that relates to fencing satisfactory?

You may want to add an addendum to the lease agreement to ensure that the fences and gates are complete before construction starts on the well. You also want to make the company responsible for locking gates. If you want to use the company access road to reach your own land, you need to ensure the responsibilities are clear.

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[30] Alberta, Weed Control Act, 2008, c W-5.1, s 35 states: "No person shall move a machine or vehicle if the movement is likely to cause the spread of a restricted, noxious or nuisance weed." These types of weeds are designated in the regulations or in local bylaws. Section 34 states: "No person shall deposit or permit to be deposited weed seeds or material containing weed seeds in a place where they might grow or spread."

Are there any trees that you want to protect?

Tell the company what they should do with any trees that are cut down and if you want the merchantable timber, logs and firewood. You may want to include a penalty for trees that are cut or damaged without your permission.

Waste management

How will drilling wastes be managed?

Try to learn as much about the types of drilling wastes that the well may produce, as they will have different risks associated with them. Decide if you want to arrange for the company to remove drilling wastes from your land or to deal with them in a specific way. It is advisable to have a separate agreement that covers drilling waste specifically that specifies access to the land, payment for access, clauses on damages and method to solve disagreements. Request that the company use tanks instead of a sump to store drilling waste. If the company will store the waste on your property, negotiate the location so that any potential spills are less likely to affect you or your water sources. [See Section 8.3 for more information on environmental issues with drilling wastes and AER's document "Common Questions and Considerations for Licensees and Landowners Contemplating Directive 050 Land Application Methods"[31]]

Do you have any requirements with respect to reclamation in addition to the AER standards? How soon will reclamation be carried out if no oil or gas is found at the site?

Specify if you want the site to be planted with native species or a certified seed to prevent erosion during use of the well site or upon reclamation. See also Section 8.6.

Does the agreement require the company to immediately notify you if there is a leak, spill or accidental release from the well and to pay compensation for damage?

The AER sets standards for dealing with leaks and spills; however, you may wish to negotiate additional provisions.

[31] AER, Directive 050: Drilling Waste Management (2016).

Air quality

How long will the well be tested?
Will the company flare the gas or can they test inline?

Ask the company to evaluate the alternatives to test flaring, as it may be possible for them to test a well without flaring (Section 8.2.3). Determine if a high-efficiency incinerator *would be preferable to a flare in your location. If flare testing is necessary, find out how long the test will last and negotiate under what conditions it will be carried out. This might include air quality monitoring during the flare testing, or a collection system to capture any excess gas.*

Have you told the company if you are sensitive to air pollution?

If you or your family are very sensitive, you may want to move out or ask for flaring to be conducted only when the wind is from a direction that will blow any gases away from your residence. Clarify whether the company will compensate you for the expenses during this time. You can also request additional notification for any planned flaring or venting *events, so that you can make arrangements to avoid the area when you may be affected the most. Although AER requirements regulate individual facilities, there is currently a gap in regulations to manage the cumulative impacts of air pollution.*

For coalbed methane wells that need dewatering, how long will flaring last?

Ask if the company can install a pilot light on the flare stack, which will allow the gas to be collected in small amounts and burned intermittently instead of being vented. Ask if a high-efficiency incinerator would result in lower air pollution at your residence than a flare. Ask how soon the well might be tied in to a pipeline.

AER Directive 060[32] *includes requirements to eliminate or reduce the potential and observed impacts of these activities and to ensure that public safety concerns and environmental impacts are addressed before beginning to flare, incinerate, or vent.*

Will there be any long-term effects on air quality?

You should try to ensure that there will be no routine flaring. Inquire whether solution gas from oil wells will be released to the air, flared or piped away (Section 8.2). Find out if the company can pipe gas to an existing gas plant or install a

[32] AER, Directive 060: Upstream Petroleum Industry Flaring, Incinerating, and Venting (2016).

microturbine instead of flaring to the air. If you and your family are sensitive to emissions, ask to be informed before the company undertakes routine flaring.

If the well contains sour gas, how high will the H_2S content will be?

Make sure you are familiar with the company's emergency response plans (Section 4.6). Even with a sweet gas well or an oil well it is important to know what plans are in place to deal with an emergency.

Nuisances

How much noise will be created by the wellhead equipment and by company staff visiting the site to service it?

Ask if a compressor (Sections 6.2 and 8.5) will be located at the well site and how the noise will be minimized. Find out if oil will be trucked or piped out. You may want to ask the company to avoid trucking at night.

Is the proposed compensation adequate to cover the loss of land and inconvenience the well and access road will cause?

Make sure you have considered crop loss, adverse effects, inconvenience and nuisance when estimating the appropriate level of compensation. This might include the time you have spent working on the lease agreement, etc.

Will the company provide compensation if you are evacuated from your home, farm etc?

Compensation terms for evacuation should be included in the lease agreement.

If you are in an emergency planning zone but are not a party to an agreement, evacuation costs including stay away costs and loss of business may be your responsibility.

Will the company provide compensation if your water well is damaged?

This should be covered in the lease agreement.

Construction and expansion

Where will the pipeline be located?

If the well is successful, a pipeline will be needed. Its location can affect how you use the land (Section 5), so should be negotiated when discussing the well lease. You may *want to arrange the* right-of-way *easement for the pipeline and compression facilities at the same time as the lease agreement.*

Will the company conduct a Pre-Construction Assessment Report?

This report provides a baseline against which to measure future reclamation work. It is not mandatory, but is encouraged by AER and the industry.[33]

Are there any plans for future expansion that could affect you?

Unless it is already specified in the lease agreement, you may want to ask the company to obtain separate permission to

- *drill more than one well or expand operations beyond the initial well*
- *drill a water well on the lease*
- *construct a pipeline or above-ground powerline*
- *dispose of any sump fluids, toxic chemicals or other hazardous substances on the lease site*
- *cross your land or store any materials on land that is not included in the lease agreement.*

Is the company planning on drilling any additional wells or locate other facilities such as a compressor or dehydrator on your land or nearby?

If the company plans to locate a battery or compressor or another facility, see Section 6 for more information.

4.6 Sour oil and gas developments and emergency response plans

Sour oil is crude oil containing free sulphur, hydrogen sulphide (H_2S; see Appendix E Glossary) or other sulphur compounds; sour gas is gas that contains measurable amounts of H_2S. While many wells contain “sweet” gas (gas that does not contain measurable amounts of H_2S), an increasing proportion of wells in Alberta produce sour gas. As explained in Section 4.6.2, H_2S is acutely toxic to humans, even at low levels.[34]

[33] Alberta Environment and Parks, *Pre-construction Assessment Report for Wellsites,* C&R/IL/00-8 (2000). https://extranet.gov.ab.ca/env/infocentre/info/library/6889.pdf

[34] See also T. Guidotti, “Hydrogen Sulphide,” *Occupational Medicine* 46, no. 5 (1996), 368.

About one-fifth of the gas produced in Alberta is sour, with varying concentrations of H_2S. Much of the new H_2S-bearing hydrocarbon development in the province is happening in areas that were originally drilled for oil.[35]

4.6.1 Emergency response plans

The AER requires companies that produce sour gas to have an appropriate emergency response plan (ERP) to ensure quick action if there is an operational incident, ranging from a minor leak to a *blowout*. The AER's minimum requirements for ERPs are given in Directive 071: Emergency Preparedness and Response Requirements for the Petroleum Industry.[36]

All companies must have a corporate ERP so they can notify the public and respond to any unexpected event. The AER also requires a company to have a specific ERP for a critical sour well, a sour production facility, a sour gas pipeline or a high vapour pressure pipeline. A "critical" well (see Appendix E Glossary) is one that has a high H_2S release rate, or is close to an urban centre. The release rate is determined by both the percentage of H_2S in the gas and the amount of H_2S that can be delivered to the surface (see AER's *EnerFAQs: All About Critical Sour Wells*).[37]

Even where a site-specific ERP is not required, it is a good idea for you as a landowner or occupant to discuss safety with the company and examine its corporate ERP so you know what will be done if there is a leak or other emergency. When a company is required to have a specific ERP they must consult or notify those within the emergency planning zone.

Emergency planning zone

An emergency planning zone (EPZ) is an area surrounding a well where residents or other members of the public may be at highest risk in the event of an uncontrolled release of H_2S. The company must be prepared to respond immediately to any event in the EPZ. The zone should be large enough to protect the public, so they can be informed and evacuated in case of emergency.

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[35] AER, *Alberta's Energy Reserves & Supply/Demand Outlook for 2015,* ST98-2016, section 5.1.3.5.

[36] AER, Directive 071: Emergency Preparedness and Response Requirements for the Petroleum Industry (2009).

[37] AER, *EnerFAQs: All About Critical Sour Wells* (2015).

The basic size of the EPZ will be determined by the maximum H_2S release rate, but the actual size of the final zone must take into consideration the nature of the terrain and other site-specific features. The extent of the zone will also reflect information gathered during the public involvement process. Directive 071 sets out in detail how a company must involve local government and the public in preparing a specific ERP. The company must provide the public within the EPZ a detailed information package that includes an explanation of the potential hazards, the H_2S concentration and release rates, the company's 24-hour emergency contact telephone number, and the potential health effects of exposure to H_2S and to sulphur dioxide (SO_2), which results from the combustion of H_2S. The package will also have a description of the procedures in place for responding to an emergency. Where people may be absent for extended periods (e.g., trappers or recreational property owners) the company must inform them by registered mail.

The company must review this information with all members of the public (or with the urban director of emergency management in an urban area) and address their concerns. In addition to obtaining input into the actual ERP, the company must obtain information from all those living and working in the zone, including the exact location of their residence/workplace and exit routes, key contact names and phone numbers, so that they can be alerted if there is an emergency.[38] The company must also identify those with special needs (for example, people with health or mobility problems), who may need to be notified or evacuated earlier than the general population. An indication of the type of information that the AER expects with respect to an ERP is given in Appendix 2 of Directive 071.

Companies must update ERPs biannually, and conduct a public awareness program with residents every second year. They are responsible for ensuring resident contact information is up-to-date.[39]

Corporate emergency response plans

The AER requires all companies drilling for oil and gas to have a corporate ERP, which they can review on request. The ERP describes how a company will manage and communicate during an emergency and is used as a training manual for company employees. Directive 071 sets out the mandatory requirements for a corporate ERP. The

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[38] The Freedom of Information and Protect of Privacy Act applies to the information that a company collects about residents, and how the company can use that information.

[39] AER, Directive 071, section 14.6.

plan must, among other things, set out a system to classify emergencies, using the AER's assessment matrix:[40]

> **Alert** — The company has identified a significant problem that is confined to the lease and is progressing towards a solution. Relevant company personnel have been alerted, but no additional personal are required. The AER may or may not be contacted.
>
> **Level 1 Emergency** — The problem is complex and deteriorating and may not be contained to the lease, and off-site management are involved. The AER are notified, along with the public within the EPZ who have requested early notification. Those with special needs and others may choose to voluntarily evacuate.
>
> **Level 2 Emergency** — The hazard has likely extended past the leased area and isn't contained, which could jeopardize public health and safety. The public within the EPZ is likely notified, and could be given instructions to evacuate or shelter-in-place, according to the situation and the ERP. The company will notify the AER, the local municipality, and the regional health authority. The company may request assistance from local authorities.
>
> **Level 3 Emergency** — Control of the situation has been lost and there are off-site impacts to the public. Evacuation or shelter-in-place will likely be activated, according to the ERP. The company requires assistance from outside parties to attempt to bring the hazard under control. If the hazard progresses beyond the EPZ, notification and evacuation will depend on the level of the concentrations of the hazardous gases (H_2S, SO_2, etc.). The AER fully implements the incident management system,[41] which includes working with Alberta Emergency Management Agency (AEMA).

The ERP should set out how a company's ERP coordinates with the local municipal disaster services. As only large cities have safety professionals, if the ERP relies on

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[40] AER, Directive 071, Appendix 4.

[41] The Petroleum Industry Incident Support Plan is a provincial-level plan which directs multiple government agencies in the event of an emergency. The Energy Resources Conservation Board and the Alberta Emergency Management Agency, *Petroleum Industry Incident Support Plan* (2011). http://open.alberta.ca/dataset/923e7f34-a999-4ec0-a8b3-c9e77bb39c7b/resource/3a493c78-1a4a-4e3a-9f05-3d672769cebe/download/6512904-2011-Petroleum-Industry-Incident-Support-Plan.pdf

municipal staff to respond to a problem then the company will have to ensure that the municipality has enough staff who are adequately trained to deal with such an emergency and that they have the appropriate equipment.

There are no regulations in place regarding compensation in the event of an evacuation. The company is usually expected by the AER[42] to cover reasonable costs incurred when evacuation is due to a company incident and there is potential for harm. If there is an issue of unpaid costs between a landowner and the company, the issue may be resolved through an Alternative Dispute Resolution (ADR) in the case of multiple issues between parties, or if compensation is the only concern, the issue may need to be resolved through a small claims court. If individuals need to claim on their personal insurance policies, they should ensure that the company's declaration of an emergency was endorsed by the municipality; if not, some insurance companies may not pay out on the claim. As sour gas emergencies can be life threatening, regardless of what municipal declaration, as a landowner you should follow the instructions the company has provided.

4.6.2 Risks of sour gas

While the acute effects of H_2S are of greatest concern, there are indications that cumulative low-level exposure can also affect health, even though it is not known what levels constitute a health risk to the general public or sensitive individuals.[43] A study of medical literature conducted by Alberta's health ministry found that young, healthy adults can tolerate short-term exposure up to 10 parts per million (*ppm*) H_2S without significant effects, but that values of 2 ppm induced bronchial obstruction in individuals with mild to moderate asthma.[44] The potential impacts of exposure to SO_2 have also received increasing attention.[45] This suggests that it is advisable for those with impaired

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[42] Previously, the AER required companies to pay costs associated with evacuation.

[43] S. Roth and V. Goodwin, *Health Effects of Hydrogen Sulphide: Knowledge Gaps*, prepared for Alberta Environment (2003). http://aep.alberta.ca/air/state-of-the-environment/condition-indicators/documents/HealthEffectsHydrogenSulphide-2003.pdf

[44] Alberta Health and Wellness, *Health Effects Associated with Short-term Exposure to Low Levels of Hydrogen Sulphide — A Technical Review* (2002), v. http://www.health.alberta.ca/documents/Health-HS2-Exposure-2002.pdf

[45] Health Canada, *Human Health Risk Assessment for Sulphur Dioxide: Analysis of Ambient Exposure to and Health Effects of Sulphur Dioxide in the Canadian Population* (2016). http://publications.gc.ca/collections/collection_2016/sc-hc/H144-29-2016-eng.pdf

health to identify themselves as being in the "special need" category when a company is compiling an ERP, so that they receive early warning of any potential release.

Reducing risks

Because of public concerns about the potential risks associated with sour gas, the Provincial Advisory Committee on Public Safety and Sour Gas was set up in 2000,[46] which led to the Public Safety and Sour Gas Report in 2007.[47] The 2007 report implemented a suite of recommendations around sour gas operations in Alberta. Among these changes was the lowering of H_2S and SO_2 thresholds to prompt evacuations of the public, and a commitment to inspect critical wells at least once during or immediately prior to drilling of the critical zone.

Additionally, the AER requires that companies conduct proliferation assessments for critical sour wells, pipelines and facilities and disclose the information so that impacts on the public could be minimized.[48] The AER expects companies drilling sour gas wells that are part of a larger project to disclose the project and, where possible, the extent of the planned development (i.e., the number of wells, pipelines and processing facilities that may be needed). They ask companies within a common area to minimize the effects of sour gas developments by sharing information, pooling efforts and using common roads, pipelines, and processing facilities.

4.7 About hydraulic fracturing

Some geological formations contain significant deposits of oil or gas trapped in shale rock and other types of geological formations (e.g. sandstone). These formations cannot be produced with conventional drilling and production technology because the formations are very non-porous so the oil and gas does not "flow" to the surface like conventional oil and gas. These kinds of geological formations are generally described as "tight" or "shale" formations.

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[46] Provincial Advisory Committee on Public Safety and Sour Gas, *Public Safety and Sour Gas: Findings and Recommendations* (2000). http://www.aer.ca/documents/reports/fnlrprt.pdf

[47] Alberta Energy and Utilities Board, *Public Safety and Sour Gas Final Report* (2007). https://www.aer.ca/documents/reports/PSSG_FinalReport_2007-03.pdf

[48] AER, Directive 056, section 8.3.

Hydraulic fracturing, which is a technological combination of fracturing and horizontal drilling technology, has provided the technological solution to “cracking” the oil and gas out of the formation. It is also informally known as “fracking”.

Conventional oil and gas reservoirs have driven Alberta’s historic oil and gas production, but new conventional reservoirs are now very rare while existing production is nearly depleted. However, there are still large formations containing shale gas and tight oil that have not yet been put into production. As a result, hydraulic fracturing is expected to dominate future oil and gas production in Alberta.

There are some significant differences between hydraulic fracturing and conventional oil and gas drilling:

- greater number/density of well sites
- greater number of wells per well site
- larger volume of fluids to handle (truck traffic, increased risk of spills, etc)
- more noise from sites (compressor trucks)
- more air pollution (increased flaring, venting, diesel exhaust from compressor trucks and other transportation)
- larger, longer-lasting surface disturbances

Hydraulic fracturing operations use similar kinds of equipment as conventional operations, but there are some notable differences that increase the intensity of the operation and significantly increase traffic to and from the site during the fracturing operation.

4.7.1 Fracturing and well completion

In hydraulic fracturing, a mixture of water and other substances is injected below the surface into tight, resource-containing rock formations to fracture them and facilitate the flow of oil or gas for production. Combining this technique with horizontal drilling increases contact with the oil-producing rock layers, and has allowed substantially more oil or gas to be produced from tight reserves.

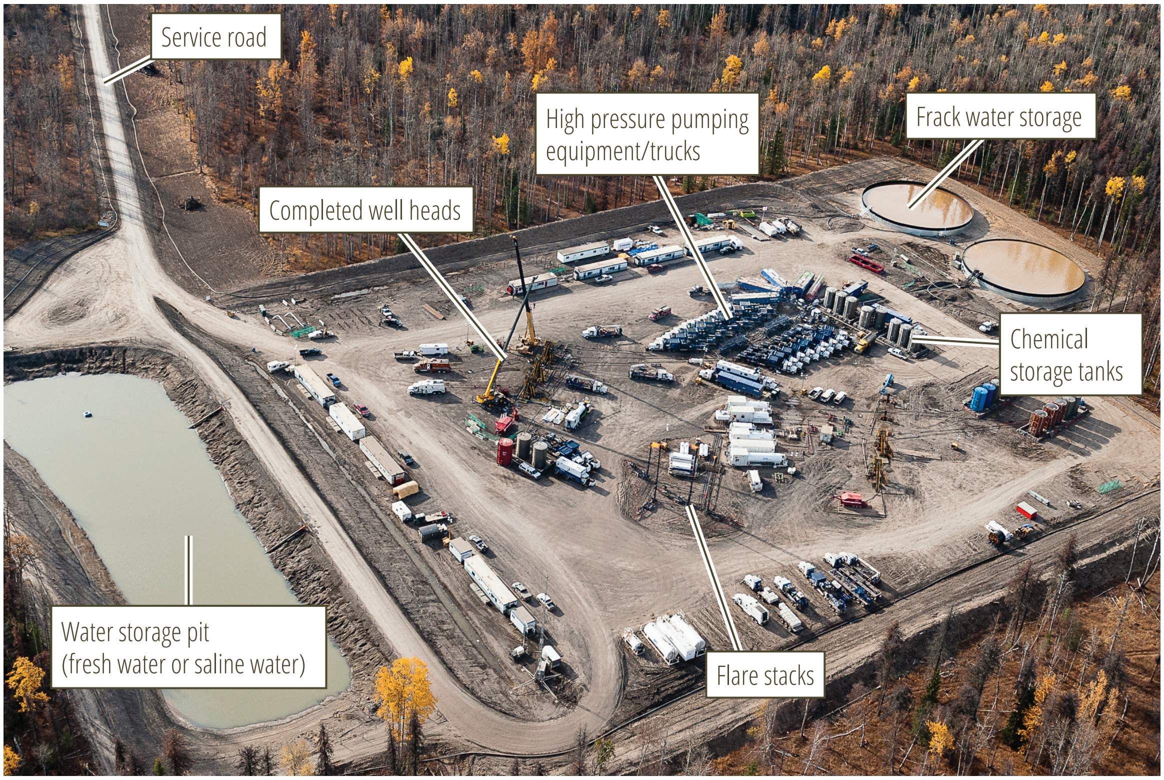

Figure 4. Hydraulic fracturing site

The fluid injected into the reservoir contains water, a number of chemical additives, and a proppant. Proppant, typically sand, holds the fractures open and facilitate production. The chemical additives serve a number of different purposes, including separating water and oil, reducing fluid viscosity, reducing friction, managing pH, managing temperature, killing bacteria, and preventing clay swelling. These additives typically make up around 1% of the fracturing fluid.

> FracFocus (fracfocus.ca) is a chemical registry website that provides information on fracturing fluids. The information that the companies are required to report to the AER via Directive 059 is now posted to the FracFocus database.

The fracturing fluid is injected in cycles to continually expand the fractures. After each pressurization and subsequent fracture, the pressure is dropped and the injection fluids, along with some *reservoir fluids* and gas, flow back to the surface. At the surface, efforts are made to separate out these fluids from the gas and subsequently store the fluids on the surface. Depending on the *operator* and location, these fluids are either reused in subsequent fracturing stages or collected to be disposed.

The gas that flows to the surface at this stage must also be managed. Early in a new development there is usually no infrastructure in place to capture and use the produced gas. Without the infrastructure to capture the produced gas (which is primarily natural gas but can include some fracture fluids, benzenes, and other hydrocarbons), it is vented, flared or incinerated. Of the three options, incineration, when properly done, provides a more complete combustion of the produced gases and generally minimizes the air pollutants released.

4.7.2 Well and subsurface integrity

In conventional production, all efforts are made to maintain reservoir pressure well below the reservoir fracture pressure. However, this is the opposite in hydraulic fracturing, where the intention is to exceed the reservoir fracture pressure to break the rock layer and allow oil or gas to flow. These higher operating pressures mean that more care is needed to ensure that damage is not done to the wellbore that would release fluids at or below the surface or that the fractures do not propagate beyond the formation to contaminate other subsurface zones.

The Alberta Energy Regulator (AER) stipulates additional requirements for hydraulic fracturing operations, in its Directive 083. To minimize this risk of wellbore damage, the Alberta Energy Regulatory requires the use of either a dual- or single-barrier system to isolate and contain fracture fluids in the event of a failure while also providing detecting and responding to failures if they arise. Single-barrier systems present higher risk and must be designed more carefully.

Fluids can also move through other existing wells drilled in the area (typically called "offset wells") to contaminate other areas or reach the surface, if a pathway between wells is created during the fracturing process. To reduce this risk, the Alberta Energy Regulator requires that all existing wells within the area be identified and assessed to determine which may be at risk of being impacted by the operation. For each existing well determined to be at risk, well control plans must be created and documented at the fracturing operation to ensure that any movement of fluid is detected and responded to accordingly. However, a significant challenge currently is that there are a large number of very old existing wells that have never been identified or catalogued, making proper identification and management of well to well transmission very difficult.

If you are aware of any existing wells in and around your lands, it is best to identify them to the developer to ensure that they take the necessary precautions to maintain well integrity.

4.7.3 Flowback fluid management

As noted above, the fracturing process occurs in cycles. After each pressurization and fracture, the pressure is dropped which allows the injection fluids and some reservoir fluids and gases to flow back up the wellbore and to the surface. These *flowback fluids* must be captured, contained, and disposed of to avoid surface contamination.

The cost of the fracturing fluid and the large volumes produced motivates reuse of these injected fluids. The produced fluids are stored on site, where they can be separated and processed for reinjection. Pits can be used to store the flowback fluid; however, due to potential contamination from leaks and spills, above-ground storage tanks should be used to minimize risk. Double-walled storage tanks provide the highest degree of protection. Single-walled storage tanks can also be used, but must include a secondary containment system such as a surrounding dike with impervious liner. AER Directive 055 outlines the technical storage requirements for the upstream oil and gas industry.[49]

The remaining fluid and drilling waste must be managed in the same manner as conventional operations, as discussed in Section 4.5.2.

4.7.4 Vehicle traffic

One of the most observable differences between traditional conventional production and hydraulic fracturing operations is the increased traffic to and from a hydraulic fracturing site. Due to the large volumes of water necessary for a fracturing operation, there is an associated increase in truck traffic to transport this water to the site and to remove the resultant wastes. This will increase traffic noise, congestion and dust in and around development areas during the fracturing process.

Some work is starting to be done to create water pipeline infrastructure that enables the transport of water to the well site without tanker trucks. You and your neighbors should ask the developer about their plans for water pipeline system as this can be a very effective way to dramatically reduce one of the largest nuisances to landowners.

[49] AER, Directive 055: Storage Requirements for the Upstream Petroleum Industry (2001).

Equitable Origins is producing a set of best management practices to ensure conformance with the EO100 Standard Provisions. The 2015 draft includes the following:[50]

> Operator ensures the integrity of the *casing* to reduce the risk of leakage of fracturing fluids, *saline groundwater* or hydrocarbons into a shallow aquifer due to imperfect sealing of the cement column around the casing.
>
> Operator ensures that wells are properly sealed before perforation and stimulation.
>
> Operator routinely tests well integrity using pressure testing and other methods that meet or go beyond regulation such as temperature, acoustic, or ultrasonic and that take into account potential decreases in well-bore integrity over time.
>
> Upon *completion*, operator ensures the integrity of plug and abandonment measures and the isolation of freshwater aquifers.

4.8 Environmental considerations of hydraulic fracturing

4.8.1 Water use

Hydraulic fracturing operations typically use more water than conventional operations. This water can be drawn from surface, *groundwater* sources or alternative sources such as reused/recycled water, wastewater, and saline sources. In most cases, because water is only needed during the initial fracture stage, operators typically apply for Temporary Diversion Licences (TDLs) to access water.

The AER posts TDL applications when they are received, which provides an opportunity for landowners who believe that they may be *directly* and *adversely affected* to submit a statement of concern. If the operation meets the low-risk criteria specified by AER technical staff, a license is automatically issued; for example, diversions of small volumes of water from borrow pits which have captured water would be automatically approved. Otherwise, the AER conducts a technical review of the TDL application.

[50] Equitable Origin, *EO100™ Standard Technical Addendum: EO100.1: Shale Oil & Gas Operations* (2015), 12. https://d2oc0ihd6a5bt.cloudfront.net/wp-content/uploads/sites/1738/2016/05/EO100-for-Shale-Oil-and-Gas_DRAFT_v2.pdf

If water is to be sourced from a groundwater aquifer that also supplies your domestic or agricultural water, it is important that you request that a company demonstrate that sufficient water is available so that the aquifer is not depleted from the additional use. Further information related to groundwater use at oil and gas operations in general can be found in Section 4.5.3.

If surface water is to be used, the licence will stipulate the operational requirements to withdraw the water. It is standard for a TDL to require use of a fish screen in fish-bearing water bodies, and to limit withdrawals from watercourses to specified rates that are established to protect other users and the aquatic environment. Operational requirements exist for groundwater use as well, such as limiting downdraw on a pumping well. If you suspect that licence requirements are not being met, you should notify the AER and provide any supporting evidence.

4.8.2 Surface water and soil contamination

Water supplies must be protected through proper storage and disposal of fracturing fluids, as well as strict wastewater storage and treatment methods. However, surface water or soil contamination can occur if fracturing or flowback fluids are not managed properly. Spills can occur during day-to-day handling of fracture fluid, when flowback fluid production exceeds storage capacity, or when fracturing fluid or wastes are being transported to and from the site. Leaks occur if equipment is damaged or improperly operated.

The responsibility to remediate surface water or soil contamination is the same as discussed in Section 8.4.

4.8.3 Groundwater contamination

A primary concern for landowners is the potential contamination of a water aquifer that may result if a fracture, fault, or damaged well creates a pathway between the fracture formation and the aquifer. A number of ways have been identified for groundwater to become contaminated, including the upward migration of natural gas and saline waters from moving along leaky well casings, natural fractures in the rock, old *abandoned* wells, or permeable faults; the fracturing itself may also damage existing well casings.[51] These pathways may allow for fluid and gas movement over long time frames and have the

[51] Council of Canadian Academies, *Environmental Impacts of Shale Gas Extraction in Canada* (2014), xiii. http://www.scienceadvice.ca/en/assessments/completed/shale-gas.aspx

potential to cause substantial cumulative impacts on subsurface water quality. The known *remediation* techniques to remove the contamination are expensive and long-term, and therefore the risk of groundwater contamination has received significant public attention.

To reduce this risk, the AER requires that any hydraulic fracturing operation operating above or within 100 metres of the *base of groundwater protection* (BGWP) must perform an additional risk assessment to evaluate the potential for contamination from the operation. If the fractures are found to encroach on the BGWP, the operation must only use fracturing fluids that will not contaminate the water aquifer. While there are substantial requirements around well construction, integrity monitoring, etc. to further reduce the risk of groundwater contamination, some concerns have been raised by landowners that these regulations do not apply to deeper fractures in certain higher risk geology (e.g. sandstone) that can result in ground water contamination.

To minimize the *adverse effects* on water wells, hydraulic fracturing operations cannot operate within 200 metres of water wells and within 100 metres vertically from the final depth of any water well.

4.8.4 Air quality

After each fracture, the pressure is dropped and the injection fluids along with some reservoir fluids and gas flow back to the surface. The fluids are separated from the gas and stored on the surface, and usually reused in subsequent fracturing stages (see Section 4.1.3). The gas that flows to the surface at this stage must also be managed. As discussed in Section 4.7.1, the lack of infrastructure with new developments can create some issues with respect to managing the produced gas. Venting, flaring and/or incineration can still release contaminants into the air. If venting, flaring or incineration are occurring or planned for in a development near you, you should discuss with the developer about the plans for collecting produced gas. Economic, environmental, and health outcomes are best if produced gas is captured and collected into pipelines.

Multistage hydraulic fracturing wells produce, vent, flare and incinerate much more *solution gas* during well testing than conventional operations do. Other additional sources of air emissions include leaks of methane and VOCs from operating equipment; emissions from diesel-powered trucks and machinery; road dust; and evaporation from storage pits and silica dust. If multiple operations in a region are fracturing simultaneously, the cumulative production of air pollutants can result in nuisance problems or, in extreme cases, health impacts.

There is emerging research about the health impacts associated with exposure to this unique mixture of gases. However, the challenge is that the complexity of the research as a result of the subsurface reactions of these chemicals and the resulting cumulative risk to the public through different routes of exposure.[52] There also remains an ongoing lack of baseline monitoring that has made it difficult to distinguish between ambient pollution and the additional pollution from these operations.[53] You should considering asking the company to complete comprehensive tests on your water supply, local airsheds etc as part of your lease.

4.8.5 Earthquakes

A number of earthquakes (also known as seismic events) have been linked to wastewater disposal and hydraulic fracturing operations, including operations in Alberta and B.C. As both wastewater disposal and hydraulic fracturing increase pressure in the sub-surface, there is a risk that they can trigger an earthquake.

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.[54] 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.[55]

This Order requires operators to monitor earthquake activity within 5 km of their wells and to develop response plans to address potential events. If an operator measures an earthquake event greater than a 2.0 local magnitude (ML) they must report the event to the AER. If an operator measures an event greater than a 4.0 ML they are required to immediately cease operations. Operations are not allowed to recommence until the AER approves.

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[52] *Environmental Impacts of Shale Gas Extraction in Canada*, 146.

[53] *Environmental Impacts of Shale Gas Extraction in Canada*, 146.

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

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

In British Columbia, there were so many concerns with earthquake activity resulting from oil and gas activity that the B.C. Oil & Gas Commission conducted two studies (the 2012 Horn River study[56] and Montney Study[57]). As a result of the studies' outcomes and increasing public concerns, the B.C. Oil & Gas Commission changed the permitting rules to require presence of ground motion monitoring during hydraulic fracturing activities and a ground motion monitoring report within 30 days of completing those activities.[58]

4.8.6 Additional questions for hydraulic fracturing operations

Background

> **What equipment will you use to store and manage flowback fluids?**
>
> *There are a few different ways of storing fluids on-site. Double-walled tanks provide the best containment, while single-walled tanks with a berm or simple lined pits provide less protection. Storage also must be the proper size to contain all fluids produced.*
>
> **What is the expected level of vehicle traffic to and from the fracturing site?**
>
> *Moving additional equipment and materials (as compared to conventional development) to the production site results in more truck traffic . This can cause a nuisance, safety concerns and damage to roads not designed for heavy truck traffic.*

Land

> **Should I expect seismic activity resulting from your operations?**
>
> *Fracturing has resulted in seismic activity in Alberta, and there are operational methods to reduce the frequency and severity of these events.*

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[56] B.C. Oil & Gas Commission, "Investigation of Observed Seismicity in the Horn River Basin" https://www.bcogc.ca/node/8046/download

[57] B.C. Oil & Gas Commission, "Investigation of Observed Seismicity in the Montney Trend" https://www.bcogc.ca/node/12291/download

[58] B.C. Oil & Gas Commission "Seismicity: What's Being Done." https://www.bcogc.ca/public-zone/seismicity/whats-being-done

Air

How will your flaring or incineration operations affect air quality in combination with other operations in the area?

Fracturing operations tend to produce larger volumes of air pollution than conventional operations. When operations are concentrated together, the cumulative air pollution can reach levels that can create odour, nuisance or potentially health impacts.

How frequently will you inspect the wells and associated infrastructure for leaks?

Methane leaks from the operations can have negative impacts on the local air quality as methane contributes to the creation of VOCs. Leaks can also contain other hazardous air pollutants.

It may be valuable to negotiate in your lease agreement that the operator follow the Best Practice guidance from EO100 on leak detection and repair:

"Operator ensures that all equipment on the well pad is equipped for minimizing methane and other air emissions, and conducts quarterly checks of this equipment to ensure it is working properly as part of a systematic Leak Detection and Repair Program."* [59]

Water

What chemical additives will you be using in your fracturing fluid?

A wide variety of different additives are used in fracturing, all with different toxicity. You should review these chemicals (information is available at fracfocus.ca) to determine what you might be exposed to.

How will your operation impact my water well?

Operations must take all measures to protect groundwater resources, especially when those resources are currently being used.

It may be valuable to negotiate in your lease agreement that the operator *follow the Best Practice guidance from EO100 on water testing:*

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[59] *EO100™ Standard Technical Addendum: EO100.1: Shale Oil & Gas Operations,* 13.

"Operator conducts baseline and post-completion sampling of individual wells and surface water within a minimum radius of 2,500 feet, or regulator limit, whichever is greater, prior to drilling of wells and installs monitoring wells to monitor the quality of water in aquifers in productive use that are being drilled through. Testing includes levels of hydrocarbons, arsenic, mercury and total dissolved solids in aquifers and surface streams."[60]

Will you provide baseline monitoring for my water well quality?

You should require in the lease that a company provide baseline monitoring for your water well to ensure any changes in water quality from the operations are recorded

Will you provide ongoing monitoring of the level of water in water well?

You should require in the lease that the company provide regular annual measurement of the level of the water in your water well. Dramatic changes in your water well level can indicate that issues have occurred as a result of fracturing activity.

[60] *EO100™ Standard Technical Addendum: EO100.1: Shale Oil & Gas Operations,* 14.

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