

BC Oil and Gas Commission

Oil and Gas Water Use in British Columbia

August 2010



For additional information on the content of this report, contact:

BC Oil and Gas Commission
300, 398 Harbour Rd.
Victoria, British Columbia V9A 0B7
PHONE: 250-419-4400 FAX: 250-419-4403
www.ogc.gov.bc.ca

TABLE OF CONTENTS

Executive Summary.....	4
Oil and Gas Development in British Columbia.....	6
Water Used in Oil and Gas Activities.....	7
Water Access for Oil and Gas Activities.....	7
Where the Water Goes.....	7
BC Oil and Gas Commission Regulated Water Use.....	8
Surface Water Authorities	
Section 8.....	9
Section 9.....	10
Section 26.....	10
Subsurface Water Authorities	
Water Source Wells.....	11
Water Injection Wells.....	11
Water Disposal Wells.....	13
Protection of Domestic Water.....	14
Subsurface Geology.....	16
Fracturing	
Fracturing Fluids.....	18
Water Use Statistics	
Surface Water.....	20
Subsurface Water.....	24
Subsurface Water Disposal and Injection.....	24
Regulating Water Use Going Forward.....	25
Associated Legislation and Regulation Appendix.....	27

Executive Summary

The BC Oil and Gas Commission (Commission) is the regulatory authority for the natural gas and oil industry within the province. The Commission has regulatory oversight responsibility for industry activity, from the exploration and development phases, through to facilities operation and decommissioning.

Oil and gas activity has been steadily on the rise in British Columbia for the past decade with unconventional drilling techniques and advanced geological knowledge creating opportunities for growth. Coupling these advances in technology and access with the increase in industry drilling activity, the amount of water used in both conventional and unconventional development has also increased.

The Commission has authority to authorize surface and subsurface water access specific to oil and gas activities within the province. Subsurface jurisdiction for water source wells, water injection wells and water disposal wells is legislated through the *Petroleum and Natural Gas Act* and associated Drilling and Production Regulation.

Through Section 17 of the *Oil and Gas Commission Act*, the Commission is the statutory decision maker for surface water authority under Section 8, Section 9 and Section 26 of the *Water Act*. This short term water use is similar to other surface water licensed or approved for industrial use in the province in that volumes are maximum approved volumes and not actual water drawn for industrial use.

The water approved from these sources is used for a number of related activities ranging from routine drilling to advanced stimulation techniques. Once the water has been used by industry, it is injected back into subsurface formations, recycled back into operations, or trucked off-site to appropriate disposal facilities. The disposal of produced water is heavily regulated through legislation. It is important to note there is no surface discharge of produced water from oil and gas activities allowed in British Columbia.

In fiscal 2009, the Commission approved (Section 8) a total of 78,569 dam³ (1 cubic decametre = 1,000 m³) for use from surface sources for oil and gas activities within the province. This number is representative of maximum permitted water volumes, not the actual amount withdrawn.

When compared to other consumptive users in the province, review of the water approval information indicates that oil and gas operations use only a fraction of the total water licensed in B.C. Of this amount, a preliminary look at actual volumes drawn vs. maximum approved shows use rates of less than five per cent, based on analysis of 2009 water use in the Horn River Basin. Going forward, information technology systems such as the water portal for surface water data collection and compliance and enforcement assurance measures will give a clear picture of how much of the water approved to be used by oil and gas industry is actually consumed.

Groundwater accessibility is regulated by the Commission through the water source well application process. There are currently 40 licensed water source wells that over their lifetime have produced a total of 6,660 dam³ of water. The 40 wells range in depth from eight metres to 1,440 metres. There are 154 disposal wells licensed that have disposed of 85,856 dam³ from a multitude of sources and 502 water injection wells licensed.

Regulating change through environmental scans of the operating environment in consultation with all major stakeholders has allowed the Commission to move forward in a manner that represents the best interests of all British Columbians.

Building the technical expertise within the Commission to address water issues is a key part of regulating on a go-forward basis. The Commission has recently hired a hydrologist to improve technical and professional capacity and improve responsibilities related to water use in oil and gas activities.

The Commission's information systems department is working on a long-term strategic plan with several objectives focusing on the collection, tracking and forecasting of water use data.

The *Oil and Gas Activities Act (OGAA)* is the future of oil and gas industry regulation for the province. Technological advances driving unconventional gas developments have spurred the development of a new regulatory framework to address the enhanced legislation reflecting the needs of the people, environment, industry and government.



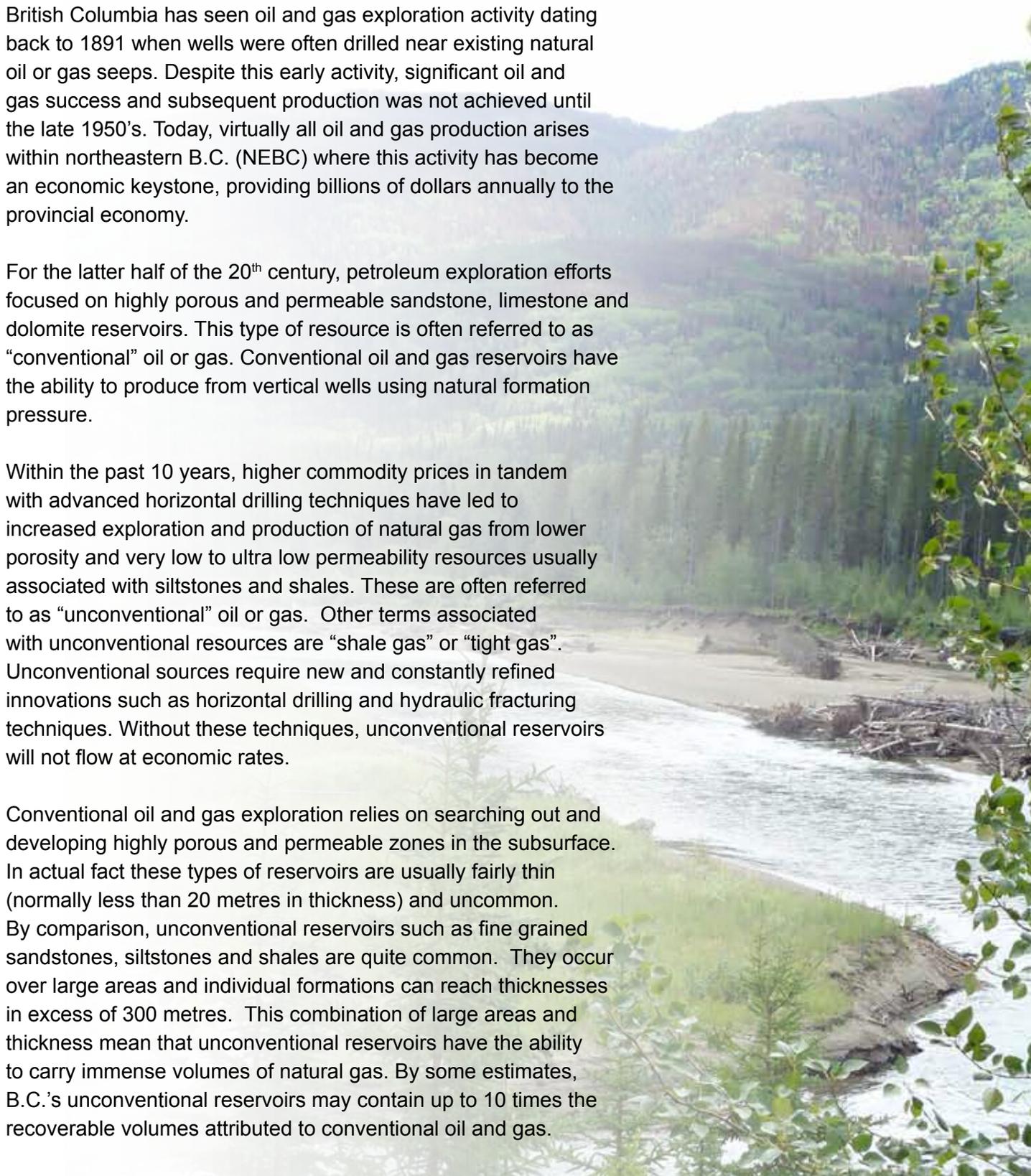
Oil and Gas Development in British Columbia

British Columbia has seen oil and gas exploration activity dating back to 1891 when wells were often drilled near existing natural oil or gas seeps. Despite this early activity, significant oil and gas success and subsequent production was not achieved until the late 1950's. Today, virtually all oil and gas production arises within northeastern B.C. (NEBC) where this activity has become an economic keystone, providing billions of dollars annually to the provincial economy.

For the latter half of the 20th century, petroleum exploration efforts focused on highly porous and permeable sandstone, limestone and dolomite reservoirs. This type of resource is often referred to as “conventional” oil or gas. Conventional oil and gas reservoirs have the ability to produce from vertical wells using natural formation pressure.

Within the past 10 years, higher commodity prices in tandem with advanced horizontal drilling techniques have led to increased exploration and production of natural gas from lower porosity and very low to ultra low permeability resources usually associated with siltstones and shales. These are often referred to as “unconventional” oil or gas. Other terms associated with unconventional resources are “shale gas” or “tight gas”. Unconventional sources require new and constantly refined innovations such as horizontal drilling and hydraulic fracturing techniques. Without these techniques, unconventional reservoirs will not flow at economic rates.

Conventional oil and gas exploration relies on searching out and developing highly porous and permeable zones in the subsurface. In actual fact these types of reservoirs are usually fairly thin (normally less than 20 metres in thickness) and uncommon. By comparison, unconventional reservoirs such as fine grained sandstones, siltstones and shales are quite common. They occur over large areas and individual formations can reach thicknesses in excess of 300 metres. This combination of large areas and thickness mean that unconventional reservoirs have the ability to carry immense volumes of natural gas. By some estimates, B.C.'s unconventional reservoirs may contain up to 10 times the recoverable volumes attributed to conventional oil and gas.



Water Used in Oil and Gas Activities

Water is used in many oil and gas related activities from routine drilling to advanced stimulation techniques. The use of water in drilling and servicing a well is vital to many oil field practices. Some of the main water use activities include, but are not limited to; hydraulic fracturing, drilling and completion of an oil or gas well, rig wash water, coolant for internal combustion engines on rigs, compressors, and other equipment, and for sanitary purposes.

“Water floods” can be used in older conventional oil fields. Water is pumped down a well to push the oil out of the reservoir so it can be pumped to the surface from other wells.

One of the main uses for water today is for hydraulic fracturing. Also known as fracturing or fracing, this technique is a critical component used in both conventional and unconventional techniques. Hydraulic fracturing has been used over the last 50 years to create fractures that extend from a wellbore drilled into targeted rock formations to optimize oil and natural gas recovery. With the realization that advances in hydraulic fracturing techniques were the key to unlocking B.C.’s vast unconventional gas potential, water has become a vital fluid for natural gas development in British Columbia.

Water Access for Oil and Gas Activities

There are numerous ways for the oil and gas industry in British Columbia to access water.

- Ministry of Environment (MOE) long-term surface water licences.
- BC Oil and Gas Commission short-term surface water use or diversion approvals.
- Commission authorized subsurface water source wells.
- As a by-product of oil and gas production.
- Agreements with others who have surface licences or groundwater access.

Where the Water Goes

Waste water or produced water (the natural salt water found in oil and gas reservoirs that is extracted along with the targeted oil and gas resource) follows a number of different paths. All fracture return water (the water that returns to the surface after hydraulic fracturing for unconventional gas development) is either recycled and used for further hydraulic fracturing, or is disposed of by injection into deep subsurface formations, through a water disposal well (refer to the Water Disposal Well section of this report). Similarly, produced water is also used, either for further resource extraction, such as reinjection into oil and gas pools to produce oil and natural gas, or is disposed of by injection through a water disposal well. Surface discharge of produced water is not allowed in British Columbia. Produced water and fracture return water are not introduced into surface waters such as lakes and streams, and are not introduced into near surface aquifers that are used for potable water supply.

BC Oil and Gas Commission Regulated Water Use

The Commission regulates aspects of the water used in oil and gas activities from both surface and subsurface sources. The scope of authority for surface water is contained under the *Water Act*, Sections 8, 9 and 26.

The Commission administers authority over subsurface water through water source wells, water injection wells and water disposal wells. Operators must report water withdrawals, injections, or disposals into associated wells on a monthly basis. This reporting is done in the same manner that oil and natural gas production is reported.



Surface Water Authorities

Section 8

Short Term Use Water Approvals are found under the *Water Act* in Section 8 and are currently issued for a term currently not exceeding 12 months unless an extension is requested. These are issued by the Commission (see Appendix) under Section 17 of the *Oil and Gas Commission Act*.

Most Section 8 water approvals are for specified diversion points on a water body. Some Section 8s, however, do not have a specific diversion point, but instead have an attached Schedule A list of larger water bodies as designated by MOE from which up to 45 m³ per day can be withdrawn.

The Commission currently approves Section 8 authorities citing maximum water volumes. Operators are required to keep actual water withdrawal data which the Commission can audit at any time. The Commission can suspend Section 8 approvals when water levels in rivers and streams become too low due to extended summer heat, low snowfall the previous winter or a combination of both; standard approval conditions address the prevention of water removal during low flow conditions.

The issuance of a Section 8 does not give the company permission to disturb or damage any soil, trees, stream bank or lakeshore, existing works or other property, construct works to transport water from the source location to a storage facility or the use site, construct any in-stream works, remove water from any beaver pond and/or damage or destroy a beaver, muskrat or other aquatic furbearer dam, house or den, upgrade or create access to facilitate water withdrawal or enter private land in order to gain access to a diversion point.

Maximum approved volumes of water are recorded on a site to site basis. All the approved individual water bodies associated water flows and water levels are specific to the water source applied for and are taken into account. Considerations when granting a permit may include:

- Any other operators using the same water source and/or diversion point.
- Habitat features such as beaver ponds and dams and known swan nesting sites.
- The length of time proposed for water use to a maximum of 12 months.

When companies estimate the daily volume of water needed for a project area, they consider the potential situations where additional water may be required. Routine day-to-day operations often require much less water. In cases where water flows could be impacted due to drought etc., industrial users are shut down first, as they are of lower priority than domestic uses and users.

For the majority of applications, approval conditions ensure the water level of a lake does not fall more than 10 cm once water withdrawal has begun, to protect shoreline habitat. Water withdrawal is suspended once maximum drawdown levels have been reached.

In streams, the water intake must be at least 30 cm from the stream bottom and maintain a minimum flow of 55 litres per second (L/s). These conditions are designed to protect aquatic habitat and to ensure water can not be withdrawn from streams without adequate flow or size.

Section 9

Changes in and about a stream are approved under authority of Section 9 of the *Water Act* (see Appendix). Examples of when these are issued are where works are required for special tasks including stream crossings, stream bank restoration, culvert replacements, bridge repairs, and/or stream bed restoration.

If additional in-stream works are required after task completion, companies must reapply to the Commission for further approvals. For winter access, companies must apply each year for their temporary winter stream crossings. Applications are cross referenced against existing approvals to ensure there are no conflicts between the works associated. If approved, a permit is then issued, listing specific terms and conditions.

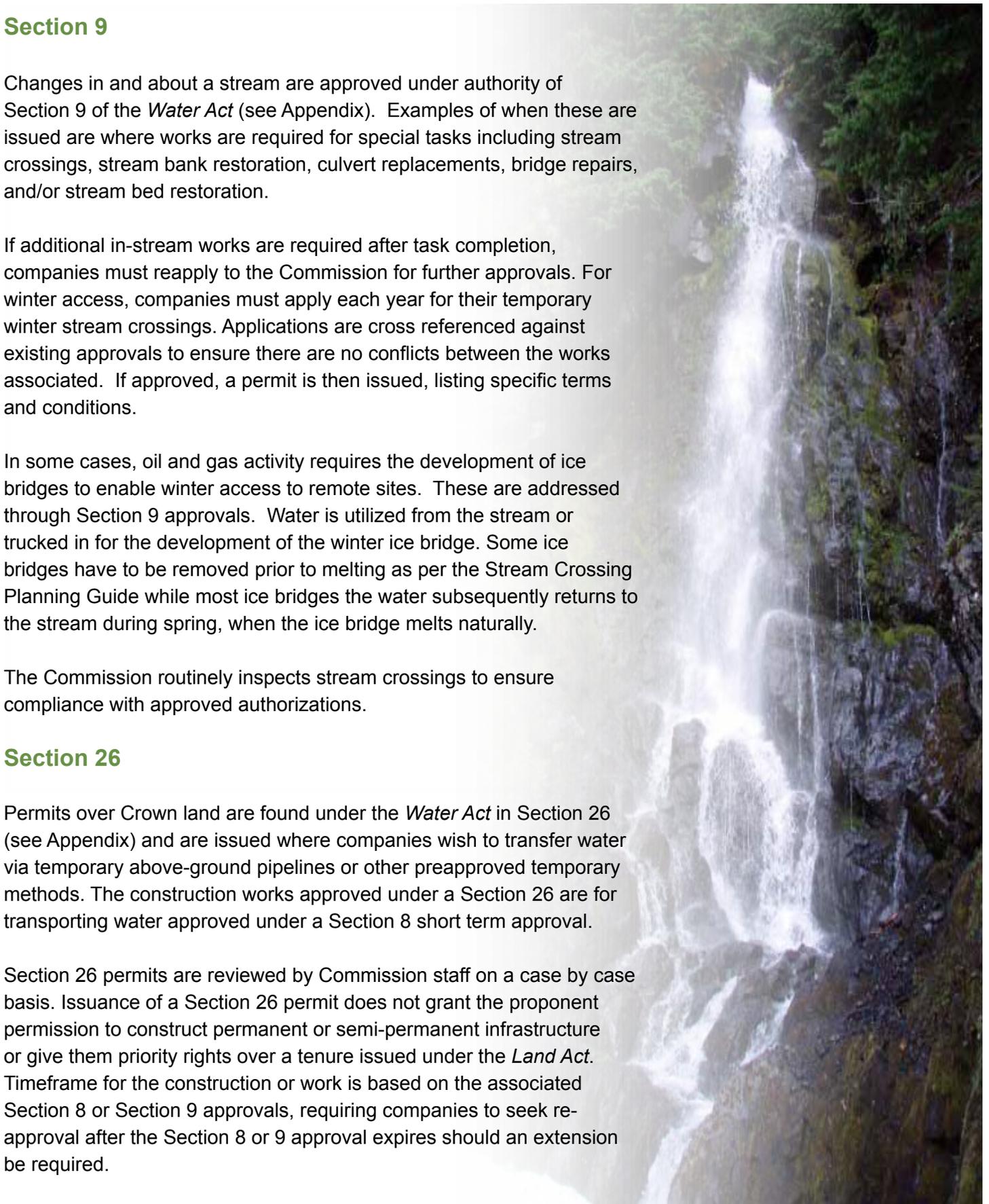
In some cases, oil and gas activity requires the development of ice bridges to enable winter access to remote sites. These are addressed through Section 9 approvals. Water is utilized from the stream or trucked in for the development of the winter ice bridge. Some ice bridges have to be removed prior to melting as per the Stream Crossing Planning Guide while most ice bridges the water subsequently returns to the stream during spring, when the ice bridge melts naturally.

The Commission routinely inspects stream crossings to ensure compliance with approved authorizations.

Section 26

Permits over Crown land are found under the *Water Act* in Section 26 (see Appendix) and are issued where companies wish to transfer water via temporary above-ground pipelines or other preapproved temporary methods. The construction works approved under a Section 26 are for transporting water approved under a Section 8 short term approval.

Section 26 permits are reviewed by Commission staff on a case by case basis. Issuance of a Section 26 permit does not grant the proponent permission to construct permanent or semi-permanent infrastructure or give them priority rights over a tenure issued under the *Land Act*. Timeframe for the construction or work is based on the associated Section 8 or Section 9 approvals, requiring companies to seek re-approval after the Section 8 or 9 approval expires should an extension be required.



Subsurface Water Authorities

Water Source Wells

The Commission regulates access to groundwater and subsurface disposal of water through authorization of water source wells and the regulation of water injection and disposal wells. Water source wells are defined in the *Petroleum and Natural Gas Act* as:

- “a hole in the ground drilled to obtain water for the purpose of injecting water into an underground formation in connection with the production of petroleum or natural gas”

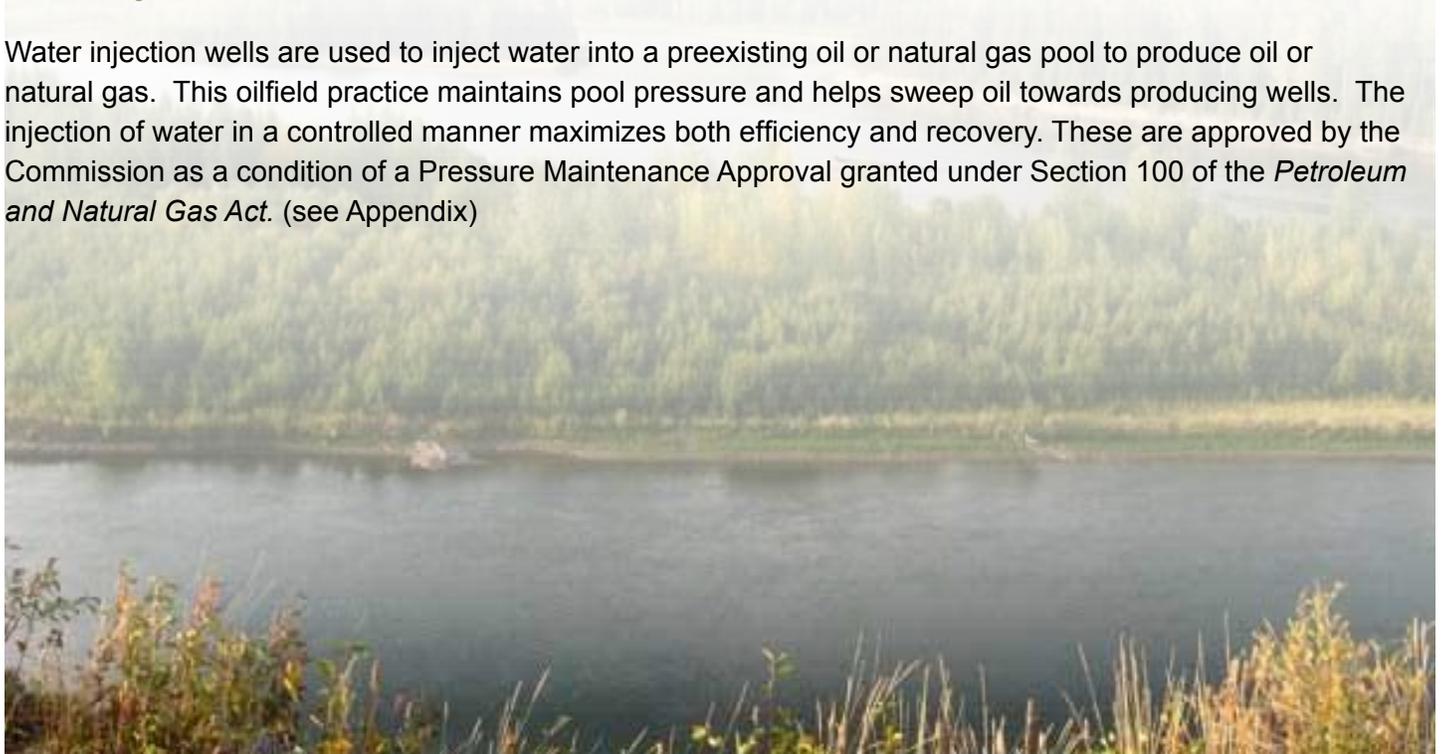
Water accessed through source wells, also known as service wells, is used in British Columbia to provide water for flooding of oil pools to enhance recovery, or to provide water for use as a hydraulic fracturing fluid method referred to as slick water fracture stimulation. These techniques can use produced water from oil and gas operations for injection, but if additional water is needed, water produced from water source wells can be used.

Produced water is the salty water trapped in the reservoir rock and that is produced along with oil or gas during production. These waters are mixed with oil, metals and minerals under high pressures and temperatures.

Water source wells for oil and gas activities are drilled the same way as any well used in domestic, agricultural or other industrial use are. Water is extracted from these wells, never injected or disposed into. If a well is used for continuous disposal or injection service, an separate application and approval with the Commission is needed prior to operation.

Water Injection Wells

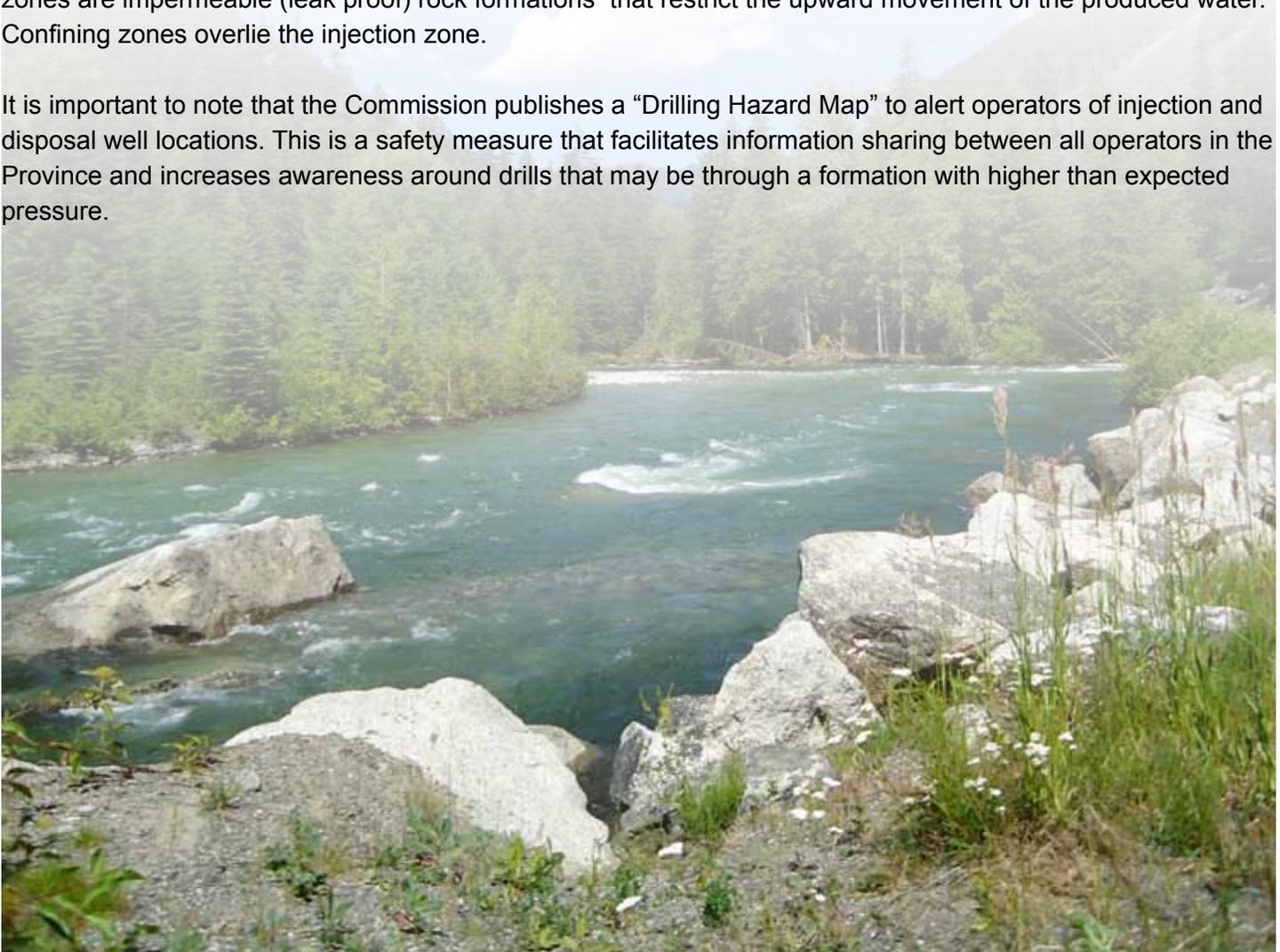
Water injection wells are used to inject water into a preexisting oil or natural gas pool to produce oil or natural gas. This oilfield practice maintains pool pressure and helps sweep oil towards producing wells. The injection of water in a controlled manner maximizes both efficiency and recovery. These are approved by the Commission as a condition of a Pressure Maintenance Approval granted under Section 100 of the *Petroleum and Natural Gas Act*. (see Appendix)



The Commission requires industry to report monthly injection or disposal volumes. A Well Authorization (WA) number is assigned through the application and approval process and an operator may convert an existing oil or gas production well to serve as an injection well. The injection or disposal well is carefully designed to confine dispersed water to an authorized geological zone and to prevent the movement of fluids to potable groundwater sources. Injection wells are drilled into geologic rock formations and are cased with steel pipe. The pipe is cemented in place to prevent the migration of fluids into potable groundwater zones. Cement is placed behind the long string casing for tens to hundreds of metres above the injection zone to prevent fluids from migrating upward. The long string casing and cement sheath are perforated in the injection zone to allow produced water to flow into the zone to be captured and permanently disposed.

The fluid pressure, fracturing pressure, water compatibility chemistry and geological characteristics of the injection zone are taken into consideration when evaluating areas suitable for injection. Confining or cap zones are impermeable (leak proof) rock formations that restrict the upward movement of the produced water. Confining zones overlie the injection zone.

It is important to note that the Commission publishes a “Drilling Hazard Map” to alert operators of injection and disposal well locations. This is a safety measure that facilitates information sharing between all operators in the Province and increases awareness around drills that may be through a formation with higher than expected pressure.



Water Disposal Wells

Oil and natural gas producing wells produce salt water from the same deep formation that the oil or gas resource is being extracted from. The natural salt water found in oil and gas reservoirs (formation water) is known as produced water when extracted along with the targeted resource.

Disposal wells, also known as service wells, return this salt water brine back into deep subsurface formations. These wells are also used for disposal of the flow-back volumes from fracture fluid returns. Fluid from either source can be disposed of in a water disposal well as long as it meets specific criteria of the targeted formation. Companies are required by the Commission to limit the injection and disposal pressure so it doesn't fracture the formation and to ensure the integrity of the disposal zone. These pressures are determined during the application approval process and are based on individual formation properties.

A thorough application review is used to minimize the potential for fluid migration between the injection zone and other zones. The operator must hold the petroleum and natural gas rights in the formation being used for disposal. The composition of the disposed fluid may require that an effluent permit be issued by the Commission. As a condition of approval, the Commission requires a Monthly Injection/Disposal Statement be submitted, reporting volume of fluid and average wellhead pressure. There are oil and gas commercial sites, approved by the Commission, that dispose of fracturing fluids.

Salt water disposal approval is granted by the Commission under Section 94 of the Drilling and Production Regulation (see Appendix).

The well approval application and approval process applies prior to drilling a new disposal well. The Commission reviews these applications to ensure:

- The proposed disposal or injection zone is compatible with the produced water or fracture returns.
- The produced water will remain within the underground formation.
- The applicant has obtained the necessary rights to the formation.
- Oil and gas resources are not impacted.

Alternatively, an operator may wish to use an existing non-productive well bore for disposal of produced water or fracture fluid returns. Companies are required to formalize this through application to the Commission.

Protection of Domestic Water

Normal depth of a potable water well for domestic purposes in NEBC is between 18 and 150 metres, far from the depth of a typical oil and gas producing zone of 800 to 3,200 metres.

The Groundwater Protection Regulation of the *Water Act* provides guidance to domestic water wells, including well casing and securing, and other requirements.

During the public engagement and project planning process, prior to development and authorization, the Commission reviews the technical requirements stipulated for the safe drilling of a well. If a landowner raises a concern regarding their domestic water well and it is not satisfactorily addressed by the operator, the Commission may apply a condition for a domestic water well pretest for water quality and quantity. Water well testing can also be stipulated as a condition set in individual oil and gas well approvals.

The drilling and production regulations include setbacks to maintain distance from domestic water wells. An operator must not drill an oil or gas well within 200 metres of a water well unless there is there written approval by the Commission to alter it. This, taken together with casing and cementing requirements into a competent formation, provide protection of domestic water wells.

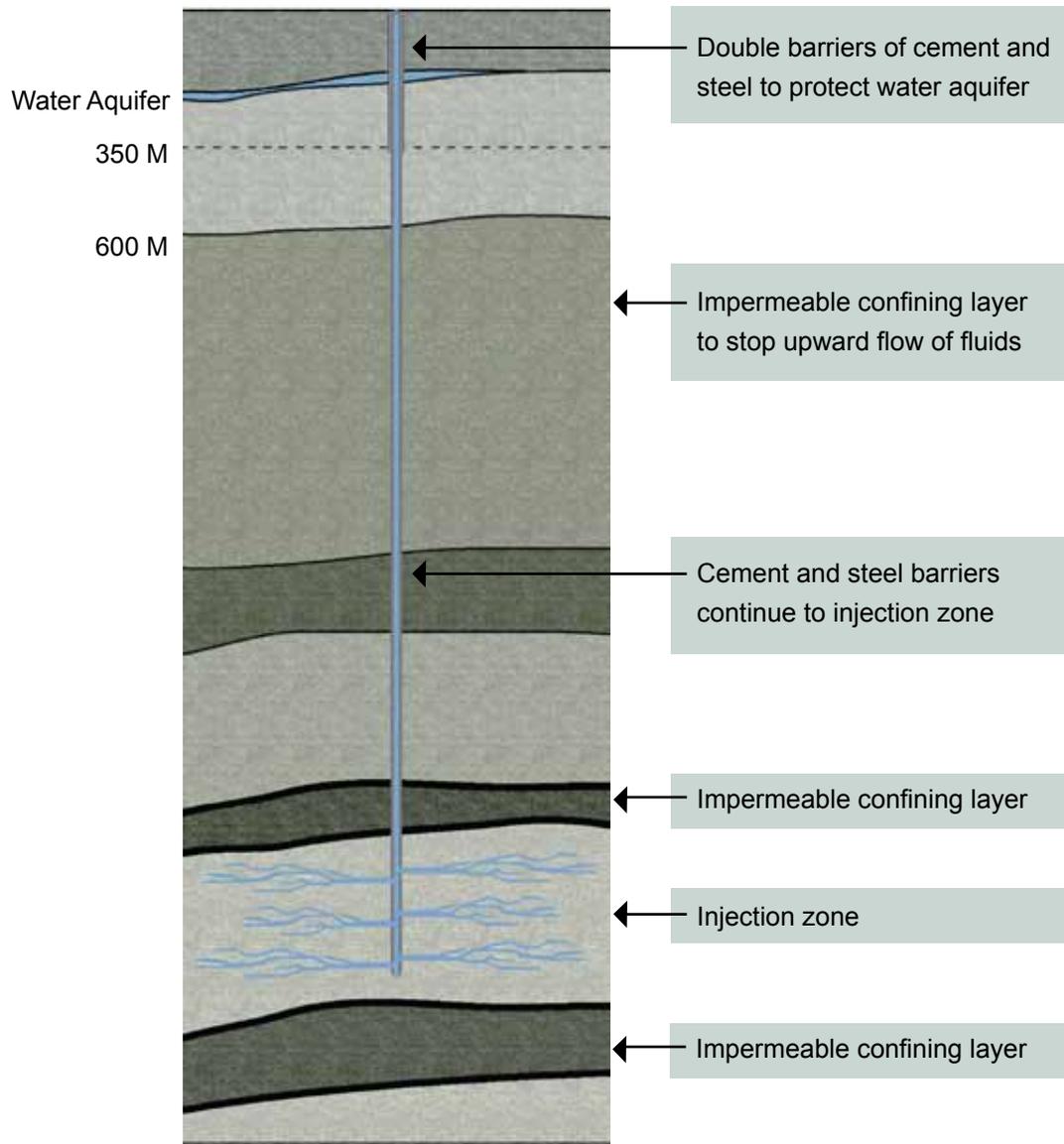
When a well is drilled, steel casing is cemented into place and pressure-tested to ensure that fluids will not migrate into water wells.

An operator of a well must ensure surface casing for a well conforms to a number of requirements. One such requirement is that surface casing must be set below the base of all strata known or reasonably expected to serve as a source of drinking water and the space left from the drill string must be filled with cement to the surface.

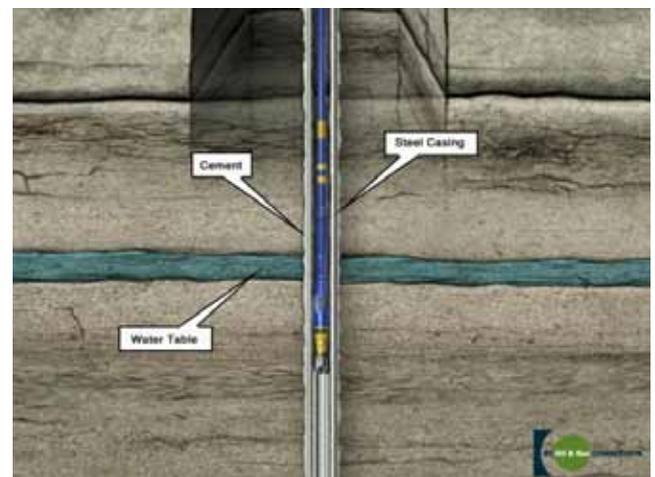
When casing is cemented into a well bore, a specialized tool, called a Cement Evaluation Log, is pulled through the well bore when deemed necessary. The information from this tool provides drilling engineers with a graphic representation of the integrity of the cement that fills the annular space between the outside of the steel casing and the wall of the borehole. If necessary, more cement is added to form a seal throughout the length of the steel casing. Casing requirements are outlined in the Drilling and Production Regulation under the *Petroleum and Natural Gas Act* (Appendix).

Commission regulations ensure that shallow potable groundwater is protected during the extraction of oil and gas. This is achieved by drilling practices prescribed in the Drilling and Production Regulations (see Appendix). Casing for water injection and disposal wells averages 350 metres based on relevant engineering and geologic factors (see the graphic on the following page).

When the well is no longer needed, for example, because the gas has been produced, the well is plugged with dense, impermeable cement across all porous rock formations, the casing is cut off at least one metre below ground level, and the well is capped with a three metre cement plug and a steel plate welded in place to seal it completely.



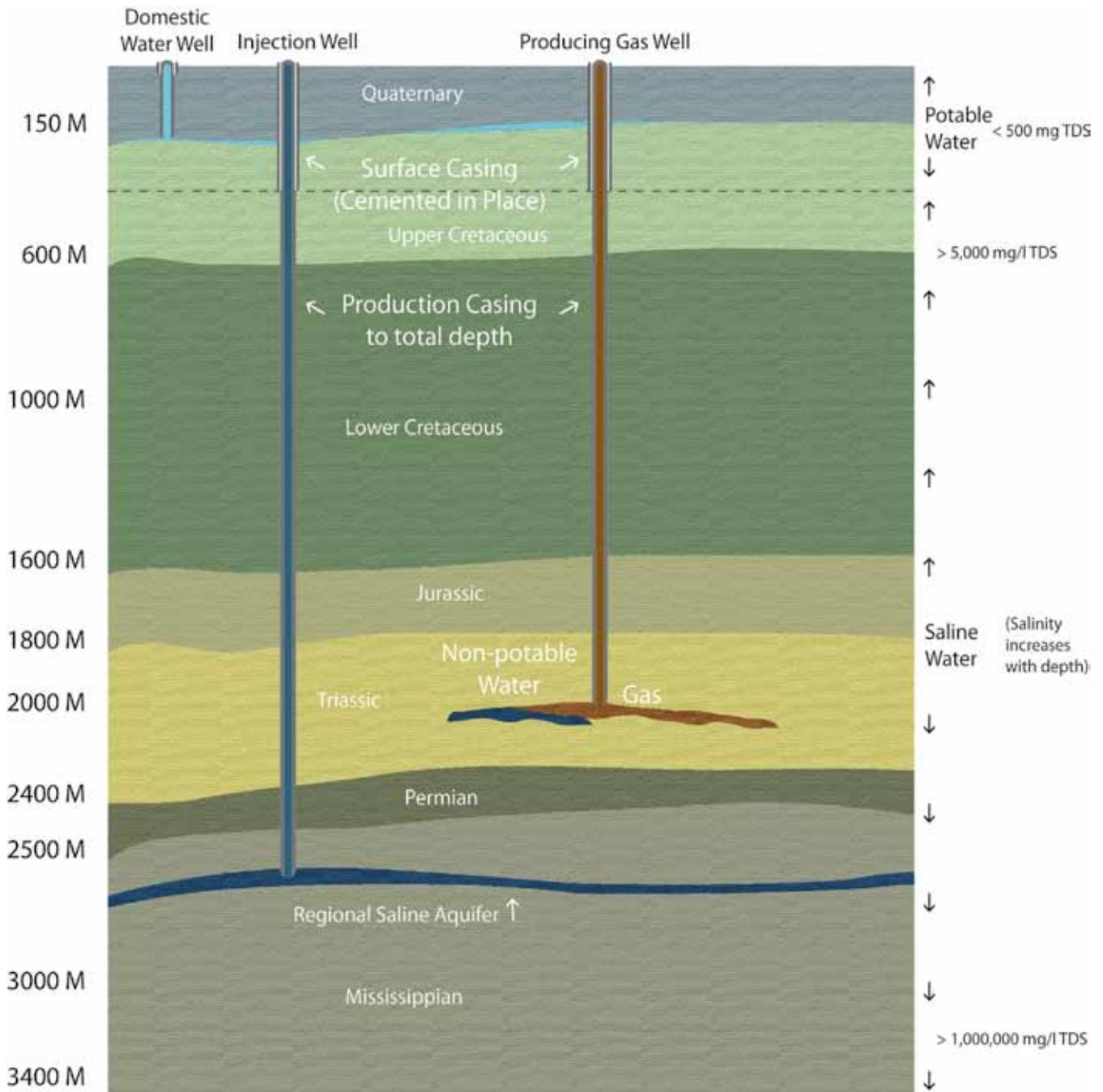
Even at the exploration stage of oil and gas production, ground water is protected. In the case of a geophysical exploration project there are specific requirements for protection including setbacks and, in the unlikely case of incident, repair of damage. Precautions can include domestic water well pretests and other stipulations before any activity takes place. See the Appendix for the *Petroleum and Natural Gas Act*, Geophysical Exploration Regulation.



Subsurface Geology

The Western Canadian Sedimentary Basin (WCSB) is a vast sedimentary basin underlying over 1.4 million square kilometres. The WCSB is a massive wedge of sedimentary rock that can reach up to six kilometres in thickness and represent a time span of over 600 million years.

Below is a graphic representation of the average depths of a domestic water well, water injection well and a producing oil well as they are situated in NEBC. The maximum depth of the water well is 150 metres; the average depth is far less.



Formations used for water disposal range from Lower Cretaceous (1200 m) to Mississippian. Scale is approximate.

Burial, pressure and heat caused sediments to consolidate into rocks and also caused organic material within the sediments to convert into oil and gas. The WCSB is known to contain one of the biggest reserves of petroleum and natural gas in the world. NEBC shares a small portion of the WCSB with three other Canadian provinces and is the locale for virtually all of B.C.'s known oil and gas reserves.

Subsurface geology in NEBC can be quite complex but generally, there is a layer of recent unconsolidated glacially derived material (Quaternary < 2.5 million years) lying on top of bedrock (> 60 million years). Depth to bedrock varies considerably from region to region from surface outcrop to greater than 500 metres. However, it commonly ranges from 50 metres to 150 metres in depth below the ground surface.

Groundwater is defined as all water occurring below the surface. Most subsurface fresh water sources are found in the shallowest unconsolidated horizons lying at depths ranging from 0-150 metres. Geologic strata that contains significant amounts of moveable water are called aquifers. Aquifers can carry fresh, brackish or saline water.

Formation or ground water quality is often described by its Total Dissolved Solids (TDS) concentration. The TDS unit of measurement is either milligrams per litre (mg/l) or parts per million (ppm).

Water Source	Total Dissolved Solids
Drinking Water	< 500 mg/L
Agricultural Standards	< 4,000 mg/L
Sea Water	30,000 to 40,000 mg/L
Formation Water in NEBC	20,000 to 200,000 mg/L

Formation waters below 600 metres are usually isolated from the near surface and can be millions of years old. Although there can be exceptions, once into bedrock and below 600 metres the formation water is saline and unsuitable for either domestic or agricultural use (< 4,000 ppm TDS). The deeper the formations are, the more likely they are to become higher in total dissolved solids and can be quite saline. In NEBC most bedrock formation waters range from 20,000 ppm to as high as 200,000 ppm TDS. As such the produced water from oil and gas operations is not considered a resource for domestic or agricultural use although they are commonly used in oilfield production practices.

Average Vertical Well Depths	
Domestic Water Well	< 150 m
Montney	2,000 to 3,000 m
Horn River Basin	1,800 to 2,500 m

Fracturing

Fracturing has occurred in oil and gas production for over 50 years. Many unconventional and conventional gas reservoirs require a stimulation phase. A physical technique called fracturing is conducted, to enhance the permeability (open-up the gas reservoir), allowing the natural gas to flow to the wellbore.

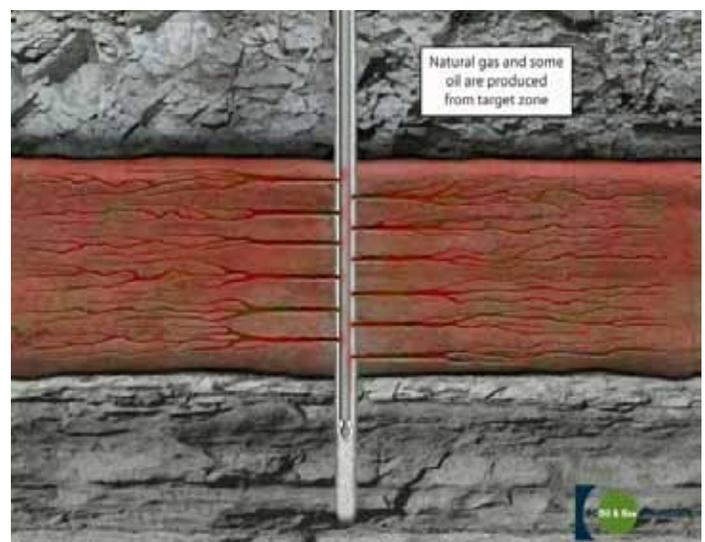
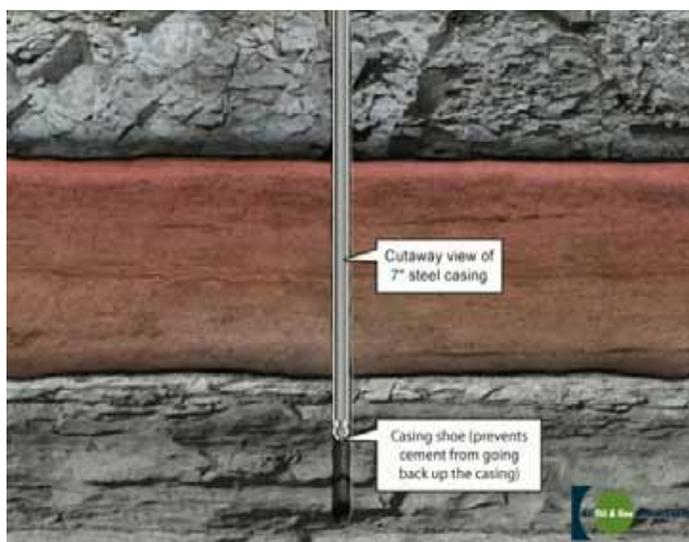
Fracturing is the process where a fluid is injected at high enough pressures to fracture or crack the rock, most commonly coal, shale or tight rock in the target zone. A hard substance (the proppant, silica sand, ceramics or resin-coated material) is mixed with the fluid to hold the cracks open once the pressure is lowered. In the fracturing process, the fluid/proppant mixture is injected into the specific level that is targeted deep below surface. These fractures/cracks are held open by the proppant, and they allow the natural gas to migrate to the wellbore.

Fracturing Fluids

Fracturing fluids vary in composition based on engineering requirements specific to the reservoir rock type that will produce the natural gas. After the fluid/proppant mixture is forced into the target rock unit, the fluid is pumped/flowed back to surface and collected at the wellsite.

The Commission has the authority to monitor and restrict fracturing operations for safety reasons. Under the new *Oil and Gas Activities Act* (OGAA) it is anticipated that more specific provisions will enable the Commission to require reports and analysis on all oil and gas related activities, including components of fracturing fluids. It is important to remember that all fracturing operations are conducted under specific pressures set as a condition of the approval and that the fracturing fluid remains in the reservoir targeted in the approval.

Most fracturing fluid is recovered at the well head during testing and production operations. In some cases this fluid may be stored, treated and re-used. When the fluid needs to be disposed, it must be trucked to an approved water disposal well or facility. When fracture fluid is injected into an approved disposal well, the composition of the fluid is tested to ensure it is compatible with the associated disposal pool because mixing incompatible waters leads to the formation of hard scale that inhibits well operation.



Fracturing fluid returns may be disposed of or treated and re-used for subsequent fracture operations. The only suitable methods of disposal are shipment to a licensed waste treatment facility or injection to the subsurface through a licensed disposal well. Acceptable storage vessels to be used prior to treatment, recycling and/or disposal include closed top tanks, open top tanks and lined, earthen excavations. There is no surface discharge of produced water in B.C.

All types of liquid fracture fluid returns may be stored in closed top tanks. Only slick water fracture fluid returns may be stored in open top tanks or lined, earthen excavations. Registration of all lined earthen excavations is required. Registration information must be submitted to the Commission Waste Management and Reclamation Unit prior to use of the lined excavation and must include the following information:

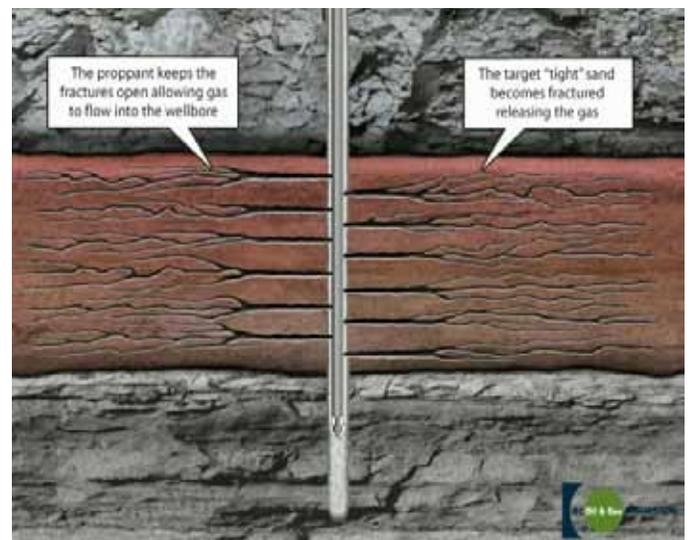
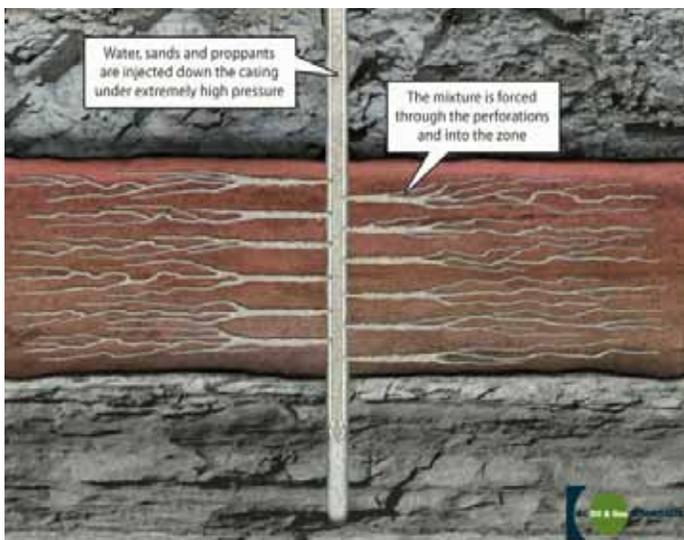
- Commission tenure file number.
- GPS coordinates of the location.
- Storage volume.
- Description of primary and secondary containment systems.
- Description of the leak detection system.
- Design life of the liner.

Registration is not required for open or closed top tanks. See Appendix A for Fracturing Fluid Storage and Containment is regulated under the *Petroleum and Natural Gas Act* Drilling Production Regulation 72 (3).

Storage of fracture fluid returns in open and closed top tanks is limited to 90 days from the last day of completion or servicing operations unless otherwise approved by the Commission Waste Management and Reclamation Unit. Liquids may be stored in lined excavations as long as tenure is maintained and the design life of the liner is not exceeded.

All sites containing tanks must be bermed to ensure that fracture fluids will not migrate off the site in the event of a tank failure. The berm may surround the entire site or may surround the tanks only.

Open top tanks must be maintained with at least one metre of freeboard at all times. Primary containment for open top tanks may be provided by an impermeable synthetic liner (i.e. corrugated steel ring with a synthetic liner) if the design is certified by a professional engineer licensed to practice in British Columbia.



Open top tanks must be inspected at least monthly for evidence of leakage and damage. Leaks must be reported to the Commission as soon as possible following their discovery.

There are specific requirements for lined earthen excavations. All lined earthen excavations must be constructed with a primary containment device, a secondary containment device, a leak detection system between the primary and secondary containment devices, adequate fencing to prevent wildlife access and unauthorized dumping, and signage at the access point identifying the operator and location.

The Commission also requires stringent inspection, monitoring and record keeping practices:

- Inspect the primary containment liner annually for evidence of leaks or damage.
- Document and maintain records of issues related to inspections and corrective actions taken.
- Document and maintain records of the leak detection monitoring. If applicable, maintain groundwater monitoring records.
- Keep all approvals, etc. on record.
- Maintain all records on file until reclamation has been completed.

Water Use Statistics

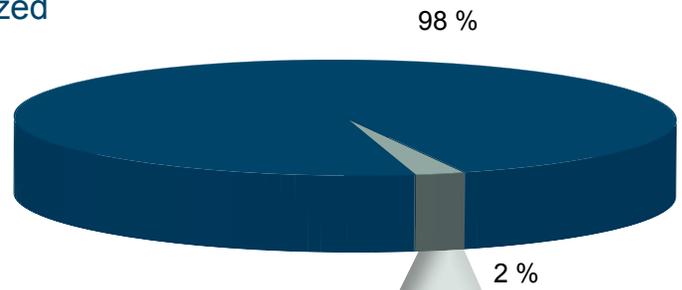
Surface Water Use

The Commission issues short term water approvals under the *Water Act* (Section 8). In fiscal 2009, the Commission issued 807 approvals, with a total maximum approved withdrawal of 78,569 dam³. One cubic decametre is equal to 1,000 cubic metres (m³) and all data shown has been rounded to the nearest whole number. Maximum approved withdrawal figures are authorized amounts, not actual volumes withdrawn.



Figure 1: Amount of Surface Water Use Authorized
Surface Water Allocated by Licence and Approval

	Waterpower	592,908,100 dam ³
	Remaining Water Uses	14,729,000 dam ³



In examining the two per cent portion of the Remaining Water Uses shown in Figure 1, water licences and approvals are further divided in Figure 2 by sector and purpose. Sector data compared below is defined by MOE and contains both consumptive and non-consumptive water.

Figure 2: Surface Water Allocated by Sector
(excluding waterpower)

	Waterworks	1,796,091 dam ³
	Mining and Petroleum	203,901 dam ³
	Industrial and Commercial	2,101,111 dam ³
	Domestic	33,782 dam ³
	Conservation and Land Improvement	8,642,800 dam ³
	Aquaculture (fish hatchery)	384,800 dam ³
	Agriculture	1,566,849 dam ³

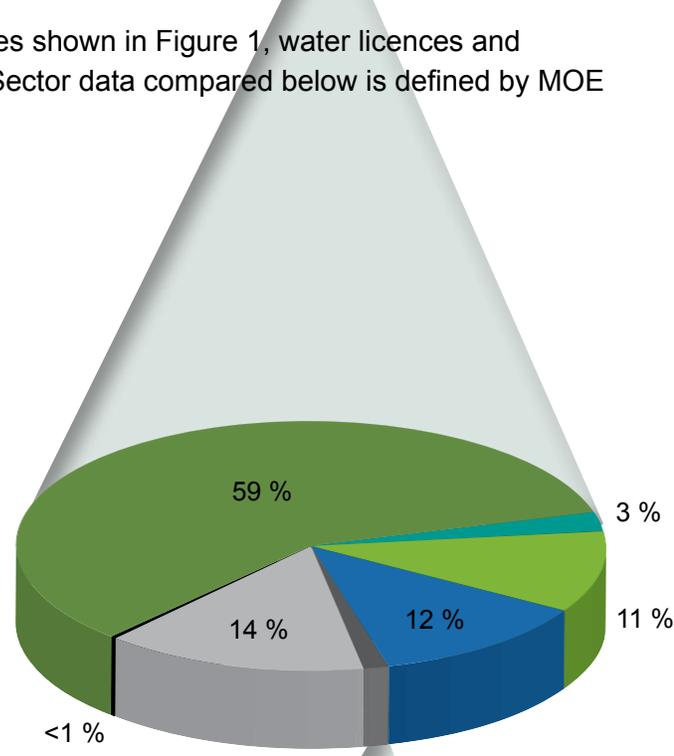


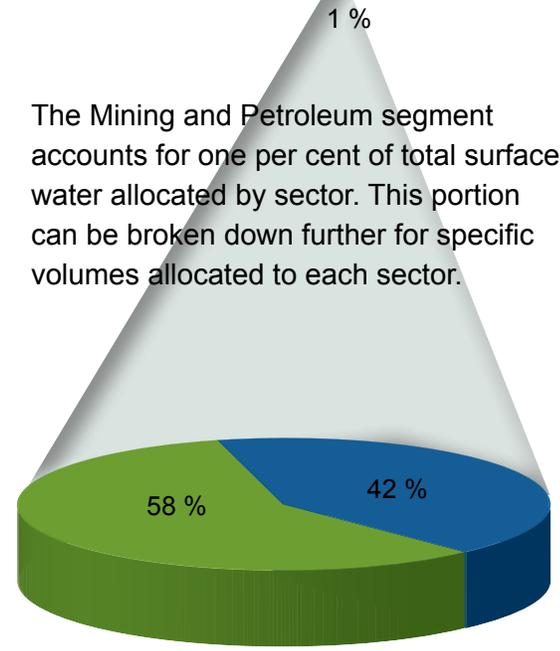
Figure 3: Comparison of Surface Water
Allocated to Oil and Gas vs. Mining
(excluding waterpower)

At 86,535 dam³, the oil and gas portion represents 42 per cent of surface water allotted to the Mining and Petroleum sector. The oil and gas portion is a combination of 78,569 dam³ authorized by the Commission for short term water use, along with 7,866 dam³ of long term water licences to oil and gas industry issued by MOE.

At 117,366 dam³, the mining portion accounts for the remaining 58 per cent.

	Mining	117,366 dam ³
	Oil and Gas	86,535 dam ³

The Mining and Petroleum segment accounts for one per cent of total surface water allocated by sector. This portion can be broken down further for specific volumes allocated to each sector.



Ninety-nine per cent of Section 8 approved water withdrawal locations are located in NEBC (one approval was granted for a drilling program on Vancouver Island, but the program is not proceeding and the water is not being used).

The total amount of water authorized to be used annually in B.C. for all purposes (authorized by water licences issued by MOE and short term water use approvals issued by the Oil and Gas Commission) total approximately 592,908,100 dam³ (based on MOE water licence data from 2006 as reported by the MOE Water Licence Information System, along with Commission data from 2009). The majority of the licensed water use is for hydro power, including BC Hydro, Rio Tinto Alcan, smaller run-of-the river hydro projects, and others. Water licences for power production comprise about 98 per cent of the total water volume licensed in B.C. These water power licences are generally non-consumptive, in that the water remains within the river system and is not removed and “consumed” for an activity.

All water licences shown in the following section are issued for maximum approved draw volumes, and do not depict actual withdrawal volumes. Total amount of surface water authorized to be used annually in B.C. by the oil and gas sector is a portion of the Remaining Water Use Figure 2.

The remaining two per cent of authorized water use (14,729,300 dam³) is allocated to a number of other sectors, including water use by the oil and gas industry (Figure 2). Of this two per cent, one per cent (203,901 dam³) is allocated to the Mining and Petroleum sectors. The remaining 99 per cent is allocated to such things as agriculture, industrial and commercial use, conservation and land improvement, community water works, aquaculture and domestic water supply.

Within the 203,901 dam³ of water allocated to the Mining and Petroleum sector, 86,535 dam³ (42 per cent) is allocated for oil and gas activities (78,569 dam³ of short term water approvals authorized by the Commission, and 7,966 dam³ of long term water licences issued by MOE), while the mining sector accounts for 117,366 dam³ of water use (58 per cent).

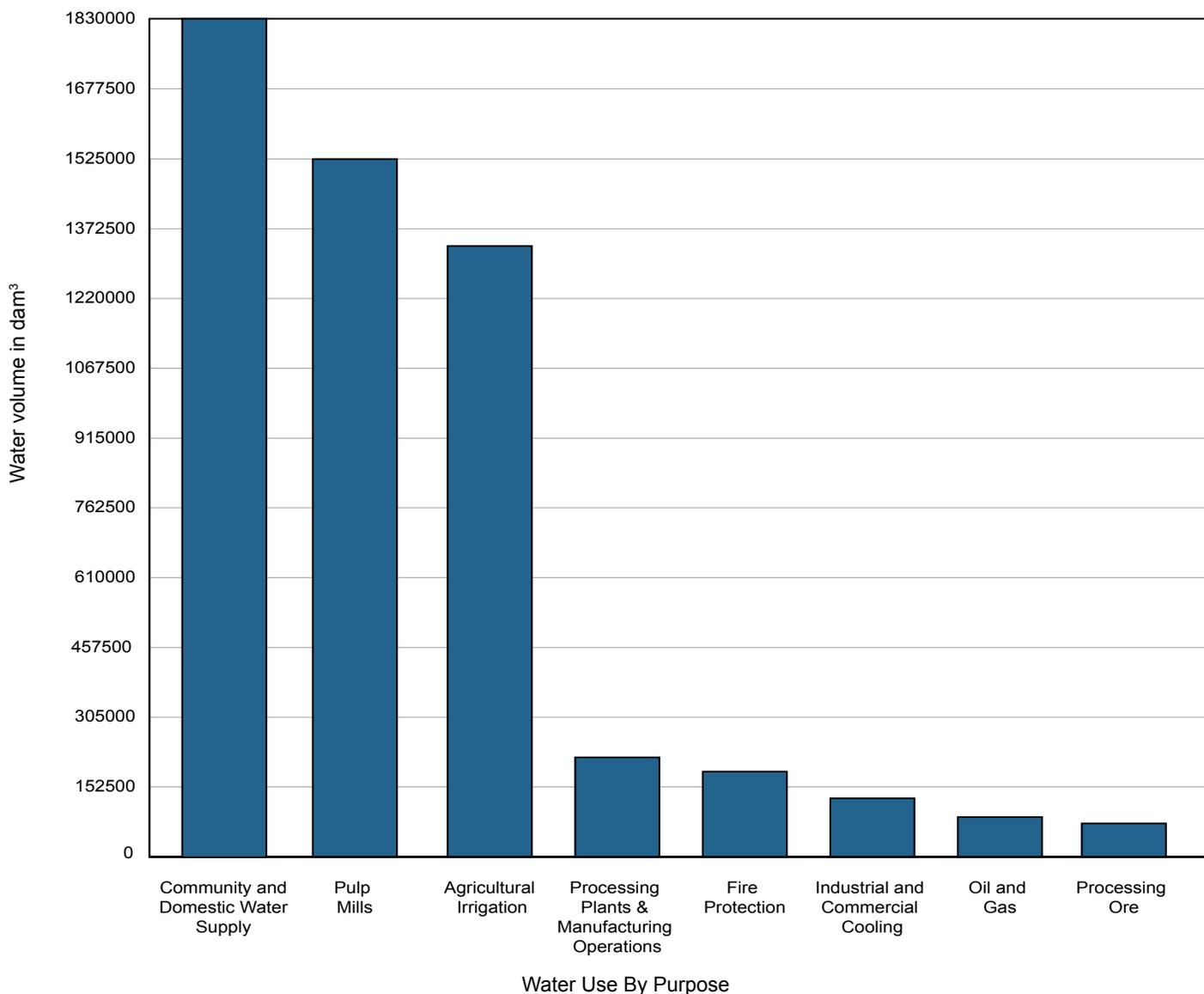
Review of the water licensed and approved across all water use sectors indicates that oil and gas operations use only a fraction of the total licensed water use in B.C. Uses of water can also be categorized as consumptive or non-consumptive. Non-consumptive uses include water power, where the water remains within the river system, and other uses where water is returned to the river system from where it was being used. Consumptive water use are those activities where water is removed from a river system, used for a purpose, and is not returned directly to the river system. These include agriculture, industrial and manufacturing uses, domestic and community water supply, and others. Oil and gas activity is defined as a consumptive water use.

Figure 4 compares consumptive water use across sectors. The data shown in the figure represents the total volume of water licensed or authorized for use, but does not represent the actual volumes used. A total of 5,289,800 dam³ of consumptive water use is licensed or authorized in B.C. Oil and gas activity accounts for one per cent of this (86,535 dam³). The largest consumptive water uses in the province include:

- Community and domestic water supply – 1,829,600 dam³ (34 per cent);
- Pulp mills – 1,525,000 dam³ (25 per cent);
- Agriculture (irrigation and other uses) – 1,385,600 dam³ (26 per cent)
- Processing plants and manufacturing – 217,000 dam³ (four per cent)
- Industrial and commercial cooling – 127,600 dam³ (two per cent)

Looking at water use across industrial sectors, oil and gas operations are a fraction of the total water licensed. At 1,525,000 dam³, pulp mills are licensed 17 times the volumes for oil and gas (86,535 dam³).

Figure 4: Consumptive Volumes Licensed and Approved by Water Use Purpose



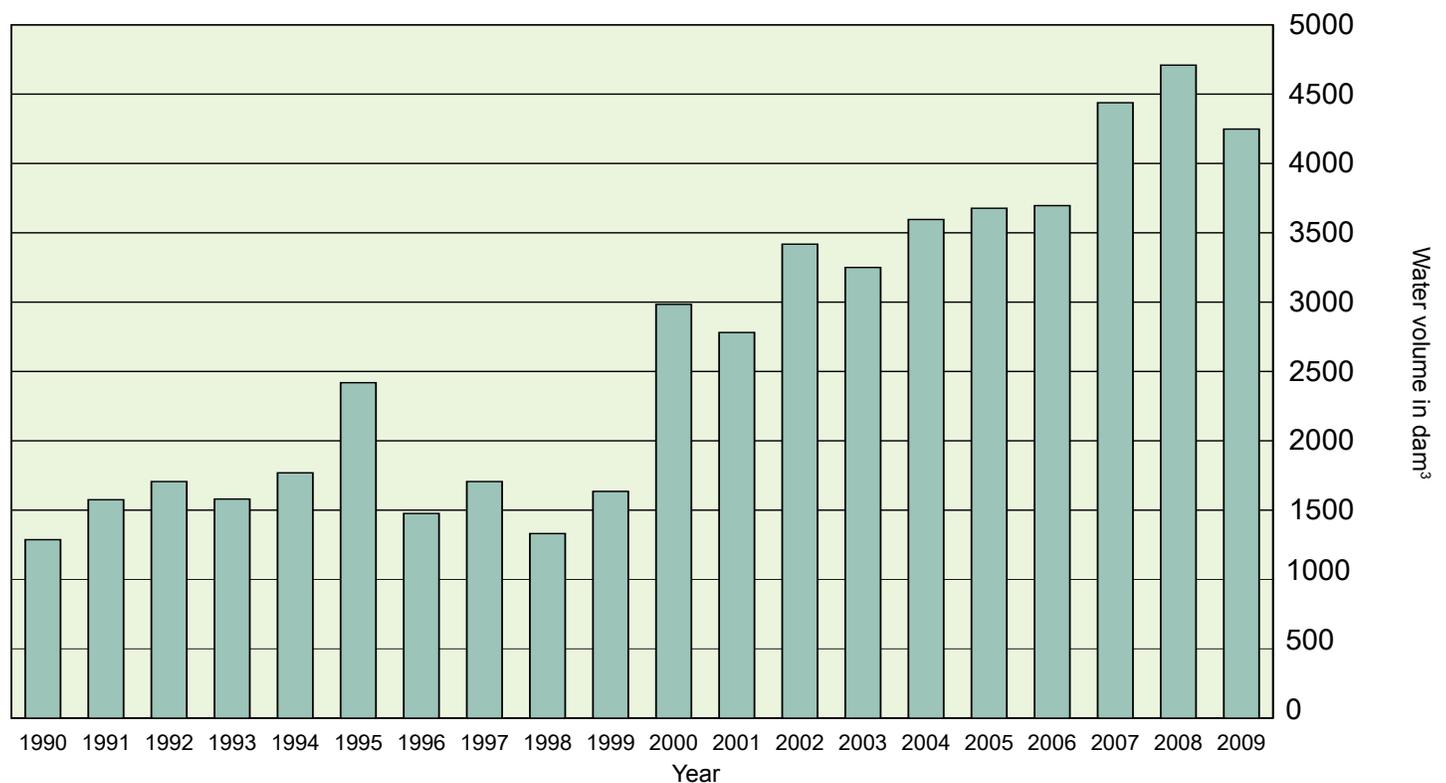
Subsurface Water Use

Groundwater access and use is overseen by the Commission through the water source well application process. There are currently 40 authorized water source wells in British Columbia, of which 11 were active in fiscal 2009. Over their lifetime (average 14 years) the 40 wells have produced a total of 6,660 dam³ of water. Unlike surface water licence where the totals are based on maximum approved volumes, the water produced from water source wells is the actual volume drawn from that source.

The 40 wells range in depth from eight metres to 1,440 metres.

Subsurface Water Disposal and Injection

Figure 5: Amount of Water Disposed Annually



Fluids that can no longer be used for oil and gas purposes or treated and recycled are injected into water disposal wells. Figure 5 shows annual disposal rates for the past 19 years.

Water injection wells are wells used to maintain pressure volumes to enhance overall oil production. Water sourced for pressure maintenance operations are varied and include surface, fresh subsurface, saline subsurface and produced water from oil and gas operations.

There are 502 water injection wells licensed in the province with a total injected volume of 262,993 dam³. Although these volumes seem large, much of the injected volume is produced water from the reservoir under pressure maintenance (i.e. the water is being cycled through the reservoir) and has a TDS rating that is much too high for domestic consumption.

Regulating Water Use Going Forward

The oil and gas industry remains a major contributor to the B.C. economy. The expansion of the industry in recent years has been driven by technological advancements, shifting towards development of natural gas from unconventional reservoirs. These reservoirs require different processes and the resulting changes in drilling programs have seen a corresponding increase in water use. As an innovative regulator, the BC Oil and Gas Commission reviews these changes, the need for regulatory responsibility and its ability to respond to industry growth.

Going forward, the *Oil and Gas Activities Act* will expand the Commission's powers to manage water withdrawals. Water accessed through both surface and subsurface methods will be tracked through increased metring, measuring and reporting.

Fracturing fluids will be monitored for content through reporting procedures added to the preexisting legislation requiring companies to have fluid composition available for Commission audit for all drilling programs.

Domestic well water testing will occur pre and post drill where appropriate.

Partnerships with other agencies through working agreements and Memorandums of Understanding (MOUs) support the Commission's proactive approach to regulation. Collaboration with MOE facilitates information sharing on a number of important aspects of water regulation. Ministry of Finance water metering through the reporting requirements as defined in regulation captures water production from natural gas and petroleum wells.

In addition, the Commission continues to participate in forums with First Nations and local communities to share information and to understand and address water management issues and concerns

The oil and gas industry is dynamic and complex, and innovations regarding all aspects of operations abound. Water use is no exception, nor the regulator's ability to respond.

The Commission facilitates and encourages the investigation into alternative sources of water, such as participating in the work done by Geoscience BC looking at the potential of using deep, non potable groundwater sources not connected to shallower potable surface water aquifers.

Another option is to investigate the use of single large water sources versus small streams which could minimize impacts resulting from accessing and transporting water from multiple smaller source streams. Additionally, promoting the use of flow-back water and use of municipal waste water (re-use and re-cycle) limits the amount of fresh water used in oil and gas operations.

Other examples of innovative partnerships responding to water use:

- The City of Dawson Creek plans to build an industry-funded reclaimed sewage water facility. In turn, industry will use the resulting “clean” water in its development of the Groundbirch field, in NEBC. The water pipeline that will ship the reclaimed water to the field will significantly cut down the amount of tanker trucks needed for delivery and water-recycling ponds built in the area will help re-use the already reclaimed water repeatedly.
- Industry’s water treatment plant in the Horn River Basin has two or three water source wells from the Debolt formation supplying two industry operator’s fluid requirements in the area. Two disposal wells will be used to dispose of the returned water into the same formation.

OGAA is the future of oil and gas industry regulation for the province. Technological advances driving unconventional gas developments have spurred the development of a new regulatory framework reflecting the needs of the people, environment, industry and government.

The Commission continues to address water issues and recently hired a hydrologist to improve technical and professional capacity.

The Commission’s information systems are focusing on the collection, tracking and forecasting of water use data. Going forward, the Commission is compiling and sharing information pertaining to the utilization of new, emerging, and alternative technologies that will assist in minimizing current and future water use.



Associated Legislation and Regulation Appendix

Water Act

Short term use of water (Section 8)

8 (1) If diversion or use of water is required for a term not exceeding 12 months, the comptroller or a regional water manager may, without issuing a licence, grant an approval in writing, approving the diversion or use, or both, of the water on the conditions the comptroller or regional water manager considers advisable.

(2) Even though a licence has not been issued, a person is not prohibited from diverting or using water in accordance with an approval given under this section or in accordance with the regulations.

(3) The provisions respecting a licence, except section 7, apply to a diversion or use of water under an approval under subsection (1) of this section or under the regulations.

Changes in and about a stream (Section 9)

9 (1) The comptroller, a regional water manager or an engineer may grant an approval in writing authorizing on the conditions he or she considers advisable

- (a) a person to make changes in and about a stream,
- (b) a minister of the Crown, either in right of Canada or of British Columbia, to make changes in and about a stream, or
- (c) a municipality to make changes in and about a stream.

(2) A minister, municipality or other person may only make changes in and about a stream in accordance with an approval under this section or in accordance with the regulations or a licence or order under this Act.

Permits over Crown Land (Section 26)

26 (1) On compliance with the regulations by a licensee or a person to whom approval was given under section 8 or 9, the comptroller or regional water manager may issue to the licensee or person one or more permits authorizing the flooding of Crown land or the construction, maintenance or operation on the land of works authorized under a licence or approval.

(2) A person must not cause Crown land to be flooded or construct, maintain or operate works on it unless the person holds a permit authorizing that flooding, construction, maintenance or operation.

Petroleum and Natural Gas Act

Approval of schemes (Section 100)

100 (1) A scheme for any of the following must not be proceeded with unless the commission, by order, approves the scheme on terms the commission specifies:

- (a) the development or production of petroleum or natural gas, or both, from a field or pool or portion of a field or pool;
- (b) the experimental application of oil field technology as defined by regulation;
- (c) the processing, storage or disposal of natural gas;
- (d) the gathering, storage and disposal of water produced from a field or pool.

(2) For the purposes of subsection (1), “development or production” includes the use of repressuring, recycling, pressure maintenance or any other enhanced recovery technique.

(3) On approving a scheme under subsection (1), the commission may, by order, waive or modify the operation of section 65 if the scheme would facilitate development and production operations or the conservation of petroleum or natural gas, or both.

(4) The commission may cancel or suspend the approval of a scheme.

- (a) at the request of the person to whom the approval was given, or
- (b) if it appears to the commission that there has been a contravention of this Act, the regulations, an order respecting the approval or a condition of the approval.

Geophysical Exploration Regulation:

Geophysical exploration near pipeline, utility, residence, etc (Section 8)

8 (1) If geophysical exploration is conducted in the vicinity of any gas, oil or water pipeline or well, electric cable, transmission line, utility, residence or other improvement, every precaution must be taken by the operator to ensure that the pipeline, well, electric cable, transmission line, utility, residence or other improvement is not damaged and that its use is not interrupted.

(2) Despite the generality of subsection (1), any method of geophysical exploration in relation to a facility described in column (1) of the Schedule must not be conducted at a distance less than the minimum distance shown in column (2) or (3).

Repair of damage (Section 16)

16 (1) If geophysical exploration causes damage to any land or property, an operator must

- (a) take immediate steps to prevent further damage, and
 - (b) repair the damage as soon as possible.
- (2) If the operator does not make the repair required by subsection (1) an authorized commission employee may order the repair

Drilling and Production Regulation:

Disposal of Water Production

94 (1) All water produced at a facility or well must be disposed of

- (a) to an underground formation in accordance with a scheme approved under section 100 (1) (d) of the Act, or
- (b) by a method acceptable to an authorized commission employee.

(2) Earthen pits may be used to contain produced salt water on an emergency basis in areas approved by an authorized commission employee, provided such earthen pits are limited to one for each well, production facility or gas processing plant, are no larger than 600 square metres in area and are constructed and maintained in a condition acceptable to an authorized commission employee.

(3) The contents of each earthen pit must be disposed of in accordance with subsection (1) within 48 hours after an emergency requiring the use of the pit has occurred, unless otherwise approved by an authorized commission employee.

(4) Repealed. [B.C. Reg. 257/2003, Sch. B, s. 8 (b).]

(5) If water is disposed of to an underground formation, a Monthly Injection/Disposal Statement, on the form provided, must be submitted to the commission not later than 25 days after the end of the month reported.

Contaminated Sites Regulation:

Storage and Disposal of Wastes

72 (3) Formation water, oil, drilling fluid, waste, chemical substances or refuse from a well, tank or other facility must not be permitted to:

- (a) create a hazard to public health or safety,
- (b) run into or contaminate any fresh water stratum or body of water or to remain in a place from which it might contaminate any fresh water or body of water,
- (c) run over or damage any land, highway or public road,
- (d) pass into any body of water frequented by fish or that flows into such water, nor on ice over either such waters, except that water base drilling fluids may be discharged into the ocean from offshore drilling operations, or
- (e) pass into any body of water frequented by migratory waterfowl or that flows into such water, nor on ice over either such waters.