# Guidelines for Coalbed Methane Projects in British Columbia

OIL AND GAS COMMISSION

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# Contents

# Introduction

The Government of British Columbia wishes to encourage development of the province's coalbed methane[1] (CBM) resource. To demonstrate that support, the Ministry of Energy and Mines (MEM, or the Ministry) is implementing a strategy to establish CBM as a clean, environmentally safe energy source that can be developed to service local, domestic, and export markets.

Despite a very large CBM potential, estimated at in the order of 90 Tcf, commercial production has yet to be initiated in British Columbia. In comparison, 7 percent of annual natural gas production in the United States is derived from CBM.

Recently, there has been increased provincial interest and activity, with 8 CBM schemes approved for development in the East Kootenays and Northeastern BC and one well on Vancouver Island. As a result, the Oil and Gas Commission (the OGC or the Commission) has decided to issue *Guidelines for Coalbed Methane Projects in British Columbia*.

## PURPOSE OF THE GUIDELINES

These guidelines are intended to clarify for project proponents and operators the existing regulatory requirements for CBM developments in the province. CBM requirements have been accommodated within the prevailing legislation and regulations for conventional petroleum and natural gas resources, notably the *Petroleum and Natural Gas Act* (PNG Act) and the *Drilling and Production Regulation* (D&P Regulation). In the future, regulations, policies, and procedures may be changed to better allow for the specific needs of CBM projects, as experience is gained.

The guidelines focus primarily on how CBM projects will be treated differently from conventional natural gas developments. For the vast majority of requirements that are identical to those for conventional gas, CBM proponents and operators should refer to the OGC website (www.ogc.gov.bc.ca), the *Oil and Gas Handbook* available from Crown Publications Inc. (www.crownpub.bc.ca) and other relevant sources (e.g., the *Maximum Disturbance Review Criteria Operating Code*). Commission staff can provide further guidance on these requirements, including the application and approval process for wells and other facilities.

## THE NATURE OF CBM DEVELOPMENT

Compared to conventional natural gas production, CBM projects have unique characteristics. Coal seams may demonstrate sufficiently low permeabilities such that they must be hydraulically fractured or stimulated to enable their dewatering and the production of gas. Effective gas recovery usually requires a number of wells to dewater the coal seam, reduce the formation pressure, and produce the CBM. The low-pressure gas is then gathered and compressed for delivery to the sales pipeline.[2]

CBM projects are normally phased, with the drilling of a few pilot wells to test potential production followed by a larger scale development that may reach tens to hundreds of wells. To ensure a commercially viable project, proponents and operators must have a clear understanding of the regulatory requirements at all stages of project development from the initial identification of a CBM prospect through project planning, drilling, production, and abandonment and site restoration.

[1] See the Glossary in Attachment 3 for a definitions of the terminology used throughout this document.
[2] For more information on CBM production, see BC Ministry of Energy and Mines, *Coalbed Methane in British Columbia*.

## OBJECTIVES OF CBM REGULATION

The OGC recognizes the unique nature of CBM, the challenges faced by project developers, and the unproven commercial viability of development in British Columbia. CBM projects are usually characterized by high up-front capital expenditures, relatively high operating costs, and production rates that may be lower than many conventional natural gas projects. Consequently, where warranted and prudent, the Commission will be flexible in accommodating CBM developments to recognize these unique characteristics.

At the same time, it is recognized that, as CBM projects grow, they can have significant implications for the environment, local community, and worker and public safety. Existing policy and regulations, including those under the D&P Regulation, *Oil and Gas Waste Regulation*, and *Waste Management Act*, are designed to address such matters. In addition, Commission staff are willing to work closely with proponents and operators to help them gain a clear understanding of the regulatory requirements as they develop and implement an effective program for managing environmental and community impacts.

Overall, the OGC objective is to regulate CBM activity in a manner that will facilitate its development in the province, while ensuring protection of the resource, the environment, workers, and the public. That is, the Commission is seeking to develop regulation that balances the interests of all stakeholders.

## ONGOING COMMUNICATION WITH THE COMMISSION

It is recommended that CBM proponents contact the OGC as early as possible when planning and developing their projects to allow time to confer on technical aspects, waste management, environmental and community impacts, public consultation, and other key matters. This contact should continue throughout the planning, development, and production phases, with the proponent or operator providing up-to-date information on the project's progress and schedule. Only through ongoing communication can the Commission fully understand a CBM project and regulate it appropriately.

OGC staff specializing in the various areas described below are listed in the Contacts in Attachment 1. For general information on CBM policy in British Columbia, proponents and operators should contact MEM's New Ventures Branch (see General CBM Policy contact).

## STRUCTURE OF THE GUIDELINES

These guidelines are organized by topic area as follows:

- Geophysical exploration;
- Well approvals
- Drilling and well servicing;
- Gathering system and pipelines;
- Production; and
- Abandonment and Reclamation.

Figure 1 provides a flowchart of the Commission's regulatory process for CBM projects.

## Figure 1: Oil and Gas Commission Regulatory Process for Coalbed Methane Projects

**[attached to end of paper]**

# Geophysical Exploration

All exploration or seismic operations in British Columbia are authorized under Part 4 (Geophysical Exploration) of the PNG, with requirements specified in the *Geophysical Exploration Regulation*. Operations must also comply with provisions of the *Forest Practices Code of British Columbia Act*.

Companies wishing to undertake a geophysical exploration program are required to obtain a Geophysical Licence from the OGC's Applications and Approvals Branch. For conventional petroleum and natural gas operations, an Application for Approval of Geophysical Exploration and an accompanying Timber Harvesting and Field Assessment are submitted to the Branch, which then initiates a multidisciplinary review of the proposed program. Consultation must take place with landowners, occupants, and trappers, and with the broader public and local government within a specified radius (see *Public Involvement Guideline*). Following the review process, the Commission issues a Letter of Approval, including any necessary conditions on the seismic activity.

Geophysical exploration requirements are essentially the same for CBM and conventional gas projects. The key differences are that CBM development is likely to be scattered throughout the province, and that the public is unacquainted with coalbed methane and its impacts. Therefore, companies may be required to conduct enhanced consultation with landowners and the public in order to inform and educate them with respect to CBM (see further under Well Approvals).

As with conventional gas development, the OGC provides a single-window review of geophysical exploration programs, with referrals to the regional/district offices of the Ministry of Energy and Mines, Ministry of Forests, Minister of Water, Land and Air Protection, and other agencies. The only exception occurs for projects that are located on Agricultural Land Reserve lands outside of the Peace River and Northern Rockies Districts, which must obtain a separate approval from the Land Reserve Commission.

Companies should refer to the *Geophysical Exploration Regulation* and Section 4 of the *Oil and Gas Handbook* for information on minimum drilling distances from structures and residences, licences to cut, stream crossings, construction requirements, reclamation, and other matters. The landowner's consent must be secured, through a negotiated agreement, before a seismic operation can be carried out on private property (see *Seismic Operations and the Landowner* and the discussion of Surface Access below).

For companies that are unfamiliar with oil and gas exploration in BC, it is recommended that they contact the Applications and Approvals Branch (see Geophysical Exploration under Contacts) to receive further guidance on the regulatory requirements.

# Well Approvals

## PETROLEUM AND NATURAL GAS RIGHTS

### Provincial Rights

Most of British Columbia's petroleum and natural gas rights are owned by the province, except in areas of early settlement such as Vancouver Island and the Fraser Valley where the surface landowner owns the subsurface rights. The Ministry of Energy and Mines' Titles Branch is responsible for issuing and administering provincially owned oil and gas tenures.

The process for acquiring rights from the Crown is no different for CBM than for conventional natural gas, since subsurface petroleum and natural gas tenures also carry the rights to any coalbed methane in the area. Companies wishing to acquire the rights to specific areas request that they be included in one of the Titles Branch's monthly sales. Once all requests have been received for a specific sale, MEM refers them to First Nations, local governments, and other agencies for review and comment. Following a review period of approximately 4 weeks, the returned comments are collated and significant concerns may be expressed as conditions of the tenure document. For locations outside Northeastern BC, additional processing time may be required for the Ministry to research the subsurface ownership to determine the extent of Crown rights in the area of interest (particularly on Vancouver Island).

A public tender notice is then published in local newspapers and trade journals, with details provided in the BC Gazette and on the MEM website. This notice includes the geographic location of the parcel, the length of time tenure will be issued for, the annual rent, and specific conditions with which the successful bidder must comply. The sale is held on the scheduled date and companies submit sealed bids. Tenure is awarded to the company with the highest reasonable bid.

There are three types of tenure agreements used in the province:

- Permits carry an obligation to conduct exploration.
- Drilling licences convey the exclusive right to drill wells in a defined area.
- Leases provide exclusive drilling rights and allow production.

Parts of permits and drilling licences may be converted to leases if all obligations have been met. Typically, agreements run for 3 to 10 years, and can be renewed or extended if certain conditions are satisfied.

### Private (Freehold) Rights

Privately held petroleum and natural gas rights exist throughout British Columbia, but are mainly concentrated in early settlement areas. In the late 1800s and early 1900s, the province included petroleum and natural gas rights with some grants of land.

It is a CBM proponent's responsibility to identify all holders of private rights in the area in which geophysical exploration, drilling, and/or production are to take place. Private rights may be identified through research in the appropriate Land Titles Office for the region. Proponents should also check with the Titles Branch for information on the area of interest.

The provincial government recognizes the need to better understand the picture of subsurface rights ownership in BC. As a result, MEM is in the process of initiating a major subsurface title research project. This is a significant undertaking and the project will be implemented over 5 years, with an initial focus on Vancouver Island.

## SURFACE ACCESS

The *Petroleum and Natural Gas Act* (Part 3) provides for the entry, occupation, or use of publicly held land in order to explore for, develop, or produce petroleum and natural gas in BC. To secure access to private land, the company must approach the landowner, usually through a land agent, and negotiate an agreement called a Surface Lease. A Surface Lease allows the company to enter onto the land to drill a well or construct and maintain any above ground structures, in exchange for a rental payment that must be renegotiated every 5 years. The requirements for surface leases and pipeline right of ways are described in *Surface Rights in British Columbia: A Guide to the Legislation and Regulations for the Oil and Gas Industry*.

Where an agreement cannot be reached, the company may apply to the Mediation and Arbitration Board for a Right-of-Entry Order under section 16 of the PNG Act. A hearing will be held to attempt to mediate an agreement between the parties. If that fails, a Right-of-Entry Order may be issued allowing the company entry in return for compensation to the landowner for loss or damage caused.

A company must obtain either a Surface Lease or Right-of-Entry Order, to be filed with the Registrar of Land Titles, before entering onto private land.

## EXPERIMENTAL AND NATURAL GAS SCHEMES

Section 100 of the PNG Act allows for the approval of special schemes that involve "the experimental application of oil field technology". An experimental scheme, as defined by the D&P Regulation, is one that uses "methods that are untried or unproved". Experimental schemes offer the benefits of flexible well spacing and an extended period for confidentiality of well data (see Well Spacing and Site Size and Data Reporting and Confidentiality).

Since coalbed methane development is new to the province, and CBM wells have uncertain lives and gas production profiles, all project applications submitted before December 31, 2003 may be approved as experimental schemes. An operator can apply to the OGC for an experimental scheme covering a continuous block of land, provided that the petroleum and natural gas rights for the area have been secured. The Commission then publishes a notice of the application in the BC Gazette. Over a period of about 3 weeks, any potentially affected party having surface or subsurface concerns with the application can provide written comments to the OGC, which may result in conditions being attached to the approval. The Commission approval stipulates the area covered by the experimental scheme, requirements for flaring and data reporting, and other terms and conditions (see Data Reporting under Production).

Recent revisions to the PNG Act have expanded Section 100 to provide for schemes for the development or production of natural gas in addition to experimental schemes. Regulatory revisions are now being drafted to support the revised Act. It is anticipated that as of January 1, 2004, CBM project applications may be approved as schemes for the development or production of natural gas. The approval process will be similar to that outlined above for experimental schemes.

Scheme approvals for CBM projects, either as experimental or natural gas schemes, may waive the spacing requirements for wells. The OGC's intention is to waive the spacing requirements for schemes approved for CBM development and production unless project-specific conditions dictate otherwise. The removal of the spacing requirements allows the scheme operator to locate wells as required to optimally develop the project.

Proponents having no experience with schemes are encouraged to make early contact with the Commission's Engineering and Geology Branch (see Experimental Scheme contact).

## WELL AUTHORIZATIONS

Section 15.6 of the D&P Regulation requires a Well Authorization (WA) for every gas well drilled in British Columbia. Proponents must apply to the Commission for a WA and pay a fee of $8,400 per well. In the case of a CBM experimental scheme, the proponent must separately apply and receive approval for each well drilled in the scheme.

The OGC currently has 3 pilot projects underway to test general development permits, which involve a review and approval in principle of a company's overall plans for the development of an area. CBM projects would likely be good candidates for this kind of project-based review process. After the 2002/03 winter drilling season has been completed, the pilots will be reviewed and a decision will be made regarding the use of general development permits.

### Pre-application Requirements

Before a proponent can submit a WA application, several pre-application criteria must be met:

- The company must be registered with the BC Corporate Registry in the Province of British Columbia or be incorporated under the laws of Canada. (Contact the Registrar of companies at 250-397-5101.)
- A drilling deposit (minimum of $7,500) must be submitted to the Ministry of Energy and Mines as security for the proper drilling, control, completion, suspension, abandonment, reclamation, and restoration of the well and well site.
- Comprehensive general liability insurance, with a limit of $1 million naming Her Majesty the Queen and the Commission as the insured, is required to hold a Crown land surface tenure document.
- A Master Licence to Cut must be obtained for each forest district in which the proponent will harvest Crown timber. This includes all timber on Crown land whether it is merchantable or not, and also covers any Timber Reserve Areas where the Crown holds the timber rights even though the land is privately lowed. (Contact the Commission.)

The Master Licence to Cut sets out the conditions and utilization standards by which the proponent may harvest timber in the particular forest district. Once a licence has been obtained, cutting permits are issued under its terms as part of the approval documents for individual applications. If timber harvesting occurs within a woodlot, the woodlot owner is responsible for obtaining the cutting permit from the Ministry of Forests.

### Application and Approval Process

The application forms and checklists required for a WA can be found on the OGC website (www.ogc.gov.bc.ca/formschecklists.asp). Applicants who are new to oil and gas development in British Columbia are strongly urged to make an initial visit to the Commission's Fort St. John office, where Applications and Approvals Branch staff (see Well Authorization contact) can guide them through the application process. At the same time, OGC staff can advise the proponent of the various agencies, First Nations, and stakeholders that must be contacted as part of the particular approval.

When a proponent submits an application, it is checked for completeness and then reviewed for technical merit as well as potential impacts on land, fish and wildlife habitat, forest resources, stakeholders, archeology, and First Nations. All applications received by the OGC are screened as being "simple", "normal", or "complex". Depending on the project, a CBM application may require a timber harvesting and field assessment, fisheries and habitat assessment, archeological assessment, First Nations consultation, and public consultation. After the consultations and review have been completed, the Commission may issue an approval with any necessary conditions attached.

There is a single-window approval process where reviews are conducted by interdisciplinary OGC staff, with referrals as needed to other agencies. For applications that are located in Agricultural Land Reserve lands outside of the Peace River and Northern Rockies Regional Districts, a separate approval must also be obtained from the Land Reserve Commission (LRC). Currently, negotiations are underway to streamline the OGC and LRC processes and to enhance the Commission's one-window approach.

### *Public Consultation*

The proponent must identify all parties who may be impacted by a CBM scheme, and must consult with them at a level reflective of the potential impact. The OGC's *Public Involvement Guideline* provides guidance on responsibilities for public consultation, consultative tools and timing, and documentation of information. In addition, minimum distance requirements from the well site are specified for personal consultation and broader notification (see the *Maximum Disturbance Review Criteria*). Proponents are encouraged to complete their public consultation process before making a WA application, to ensure better planning and relationships with landowners, First Nations, and other affected parties.

It is recognized that the public is unacquainted with coalbed methane, and that the impacts of CBM projects can differ significantly from those of conventional oil and gas development. In particular, the longer lives of CBM wells (10 to 40 years compared to 3 to 25 years for conventional gas), and the magnitude of disturbance that can be caused by multiple wells in a given scheme, require due diligence on the part of applicants to inform and educate. The OGC is empowered to request, on a case-by-case basis, an enhanced consultative process. Proponents can expect to conduct enhanced public consultation where projects are located outside Northeastern BC or close to populated centres.

Because of the phased nature of CBM projects, the proponent will not know the ultimate scale of a development until some pilot wells have been tested. When consulting prior to an application, the proponent should inform First Nations, stakeholders, and the public of the planned impacts of the project consistent with the most reliable information available at the time. Subsequently, as development proceeds, affected parties (as well as the Commission) should be kept informed of its progress and updated on the project's scale, land and water disturbance, and other impacts.

### *First Nations*

Proponents are encouraged to consult with local First Nations on their CBM projects, including associated economic development opportunities. OGC and MEM staff will assist in identifying affected First Nations.

Consultation for potential infringement of aboriginal or treaty rights is the responsibility of government through the Commission. In Northeastern BC, Memoranda of Understanding (MOUs) and Agreements have been signed with Treaty 8 First Nations. These consultation agreements establish a time-limited review process for First Nations to provide comments to the Commission on applications referred to them. Based on the consultations and the degree of potential infringement, applications may be approved with measures to minimize impacts on First Nations interests. Copies of several MOUs can be viewed at www.ogc.gov.bc.ca/firstnations.asp#mou.

Outside the Northeast and for non–treaty First Nations, the OGC and MEM use the evolving British Columbia First Nations Consultation Guidelines to consider aboriginal rights and title in the decision process for WA applications. The guidelines are available from the Treaty Negotiation Office website at www.gov.bc.ca/tno/consult/.

In addition to the above consultations, MEM's Aboriginal Relations Branch conducts information sessions with First Nations to inform them about CBM and identify appropriate contacts for further dialogue. These sessions, which have already taken place in many areas of the province, are designed to initiate a relationship with First Nations for exploring potential impacts and opportunities associated with CBM development.

### *Well Classification*

A Well Classification will be assigned as part of the WA process. Where there is an approved experimental scheme, every well drilled in the scheme will automatically be given experimental status. If the proponent has not applied for and received approval for an experimental scheme, then the Commission will classify each CBM well as either a development well, an exploratory outpost well, or an exploratory wildcat well (section 14.1 of the D&P Regulation). For these classifications, well data will remain confidential for 2 months, 6 months, and one year, respectively, from the date of release of the drilling rig (section 57.4). All CBM wells will be identified by "CBM" in the well name.

## TEST HOLES

In addition to authorized wells, the *Petroleum and Natural Gas Act* allows for the drilling of "test holes" to obtain information about petroleum and natural gas resources. A test hole cannot be produced, but may be flow tested. An operator wishing to drill one does not require petroleum and natural gas tenure, but will need surface access for any entry onto private land.

Section 18 of the *Drilling and Production Regulation* sets out the requirements for test hole authorizations. All information from test holes is granted confidential status for 3 years after the rig release date. Test hole application forms and checklists are available from www.ogc.gov.bc.ca/formschecklists.asp.

The OGC will consider a well authorization that would have the effect of "converting" a test hole to a well. As with any natural gas well, the operator must hold natural gas tenure to apply for a well authorization. An applicant will be required to satisfy all relevant requirements of the PNG Act and D&P Regulation that pertain to wells, in order for a test hole to be considered for conversion. The applicant will also be required to pay the WA application fee.

# Drilling and Well Servicing

## WELL SPACING AND SITE SIZE

British Columbia's *Drilling and Production Regulation* (section 10.1)) requires one section, or approximately 260 hectares (640 acres), for each conventional natural gas well drilled (equivalent to one well per square mile). The target area for a conventional well excludes a 250 m setback from the boundaries of this normal spacing area (section 10.2). Conventional gas wells should not be spaced so close together that they compete for drainage of gas, but also not so far apart to prevent all of the gas reserves from being recovered.

CBM wells, on the other hand, typically benefit from closer spacing (e.g., 2, 6, or 8 wells per square mile), which can work to reduce the formation pressure, increase the methane desorption, and optimize ultimate gas recovery. The approval for an experimental or natural gas scheme under section 100 of the PNG Act allows flexibility in both the spacing of wells and the determination of the setback. Therefore, with a scheme approval, an operator will be allowed to drill wells within the scheme area to any density, subject to a reduced setback of 100 m.

For standard drilling operations, a conventional gas well typically requires a surface lease area measuring 120 by 120 m (1.44 hectares). Larger areas may be required for rigs to conduct directional, deep, or underbalanced drilling.

Because CBM wells are shallower than conventional gas wells, smaller rigs and surface areas may be used, resulting in a smaller footprint. During drilling, the area must only be of sufficient size to safely accommodate the drilling rig and all other equipment needed on the site for well development.

The OGC will consider reduced site sizes for CBM wells on a case-by-case basis, depending on the drilling and other equipment used. Lease size must be commensurate with spacing for maximum equipment requirements. Operators are encouraged to use good judgment and design their operations to leave a smaller footprint.

The Commission continues to work with the Workers Compensation Board (WCB) to determine minimum safe separation distances between equipment on CBM well sites. It is anticipated that standards will be developed incorporating reduced separation distances once the initial CBM projects demonstrate safe operations with such distances.

CBM is generally a sweet gas, consisting of methane and small amounts of carbon dioxide and nitrogen. US experience with CBM operations indicates no danger from hydrogen sulphide or sour gas, as is present in conventional natural gas. Given the lower volumes from CBM wells and the negligible risk of sour gas, it may be possible to grant reduced distances between well sites and roads.

## SURFACE CASING, BOP, AND EQUIPMENT SPACING[3]

The PNG Act (section 96.1.1) calls for "adequate measures to confine petroleum, natural gas, or water to its own stratum and to protect any coal seam or other mineral or workings in it from injury." Basically, to ensure the safety of workers and the public, the operator must be able to control a gas well at all times in all operations. This gives rise to requirements for surface casing, Blowout Prevention, and spacing of other equipment from the well.

For the drilling of a conventional gas development well up to 1850 m, a full Class A Blowout Preventor (BOP) stack with a pressure rating of 14,000 kPa is required. Surface casing must be set at least 25 m into competent formation in accordance with good oilfield practice at a depth

[3] More detailed requirements are provided in Attachment 1.

sufficient to provide a competent anchor for blowout prevention and to ensure control of anticipated pressures. The surface casing must have cement in the annulus along its full length to the surface.

Reduced surface casing, blowout prevention, and equipment spacing will be considered for CBM wells in some instances because of their lower pressures. In all cases, the ability to control anticipated pressures must be assured and all drinking water strata must be isolated.

Proponents will be expected to conform to conventional well requirements in areas lacking subsurface information. In areas where a reasonable understanding of the subsurface conditions exists, the proponent may request relaxed BOP and surface casing requirements. Operators contemplating undertaking CBM developments are urged to contact the OGC (see Surface casing/BOP contact) early in the planning process to establish surface casing and BOP requirements.

In all cases, the operator is required to conform to the Workers Compensation Board (WCB) requirements with respect to wellsite equipment spacing (*Workers Compensation Act*; *Occupation Health and Safety Regulation*, Part 23: Oil and Gas). As mentioned in the Well Spacing and Site Size section, the Commission continues to work with the WCB to develop specifications for reduced equipment separation distances that will be suitable for CBM projects.

Currently, for any reductions from full adherence to the D&P Regulation, the operator must contact the WCB (see Worker Safety contact) to ensure compliance. All drilling programs should be designed and carried out by qualified and competent personnel.

## Rig Standards[4]

In some cases, CBM wells may be drilled using rigs and crews that are normally engaged in water well drilling or mineral coring. The OGC requires that both the equipment and personnel employed in a rig be capable to do the work of drilling a gas-producing well. Operators contemplating undertaking CBM developments are urged to contact the Commission (see Equipment Spacing/Rig Standards contact) early in the planning process to confirm rig and crew acceptability.

## Samples, Logs, and Cores

For conventional gas wells, samples must be taken at 5-metre depth intervals over the entire wellbore and forwarded to the OGC (section 52.1 of the D&P Regulation). There is a minimum requirement for a gamma ray log and a resistivity and porosity log to be taken before the well is completed, suspended, or abandoned (section 53.2). Core analysis and tests performed either on the wellbore or on any samples obtained during drilling are generally left to the operator's discretion, with a copy of the results forwarded to the Commission. However, OGC staff may request that any well log, core analysis, drill-stem test, or other testing and analysis be performed on a gas well during its producing life (section 53.1).

Because CBM wells are drilled in tighter spacing than conventional gas wells, operators will likely make requests for logging and sampling waivers. The Commission will be flexible in determining which wells in a CBM scheme require the submission of samples, an open hole logging suite, cased hole logs, or no logs (complete logging waiver).

After a CBM scheme has been approved, the operator should submit a proposed sampling, logging, and coring program to the OGC's Victoria office. This proposed program will be reviewed and revised, as necessary, to ensure that a legacy of adequate data exists for the project. While operators can request modifications or waivers of logs and/or cores on a well-by-well basis, this

[4] See Attachment 1 for more detail on these requirements.

approach is more cumbersome and is not recommended. In any case, all information collected (samples, cores, etc.) must be forwarded to the Commission in a timely fashion.

In the case of test holes, the OGC may attach any requirements for logs, tests, or analyses as conditions of the authorization (section 18.7). The results of any such testing must be forwarded to the Commission within 30 days.

## FLOW TESTING AND FLARING

Flaring is frequently required during the initial flow testing of natural gas wells (see Gas Well Tests under Production), and during completion stages or workovers. The OGC regulates flaring under section 71(4) of the D&P Regulation. Flaring is limited in its duration and extent to allow for adequate testing while ensuring conservation of the resource and the minimization of air emissions.

For CBM wells, a longer up-front flaring period may be necessary because of the initial dewatering process and low early volumes of gas. It may take several months to a year for production tests to demonstrate representative gas rates. Further, additional flaring may be required during the production phase, for example, if compressors (see Gathering System and Pipelines) go down.

The Commission will consider allowing longer than normal flaring of CBM wells for initial flow testing, subject to a maximum volume of flared gas per well. The maximum flaring period and volume will be specified in the approval for a CBM experimental scheme or Well Authorization. As with conventional gas production, flaring during compressor downtime and other planned or unforeseen events must be kept to a minimum.

## APPROVALS

With multiple wells in a CBM scheme, projects are likely to involve a substantial number of workovers and completions, for example, fracturing, perforating, or cavitation. Key approvals that may be required during the drilling phase include:

- An Application to Alter a Well is submitted before the well's production characteristics are changed, such as an initial completion or workover.
- An Application for Flaring Approval is submitted 5 days before any flow test or other flaring operations.
- OGC approval must be obtained for a cavitation program, including the proposed procedure for coal fines containment.

The Commission is currently preparing an information letter that will require notification, rather than application, for the initial completion of any oil, natural gas, or CBM well. Similarly, flaring upon initial completion of a well will be on a notification basis, subject to volume limits that have yet to be determined.

## PRODUCED WATER MANAGEMENT

The process of de-pressuring the coal seam can generate large volumes of water of varying quality from fresh to highly saline. Subsurface water is regulated under the D&P Regulation, which requires that water produced from natural gas operations, including CBM, be disposed of in an underground formation, unless otherwise permitted (section 94.4). Water discharged to the surface is viewed dealt with under the provincial *Waste Management Act* on a case-by-case basis.

### Surface Disposal

At the present time, an operator must apply for a permit (section 10) or approval (section 11) under the *Waste Management Act* to enable the surface disposal of water produced from a gas well. The application is made to the OGC and forwarded to the Ministry of Water, Land and Air Protection (MWLAP) for review and comment. MWLAP, as the province's environmental authority, ensures that the proposed water disposal conforms to provincial requirements and provides recommendations to the Commission regarding the disposal application. The OGC may then issue a permit or approval, usually with conditions based on MWLAP recommendations.

Currently, to determine whether a type of surface disposal is appropriate, CBM produced water must be rigorously tested for total dissolved solids (e.g., salts) and other pollutants (based on *Draft Standards for the Discharge of Produced Water from Coal Bed Methane Operations – Draft: July 8, 2002 Version*). Only water that is screened against the Standards document and has been authorized by a permit may be discharged.

In order to facilitate the processing of a CBM produced water surface disposal application, an operator should consult the above Standards document, as well as the *Procedures for Using* and *Rationale to Accompany* the standards. The Commission and the Environmental Protection Division of the appropriate MWLAP regional office should be contacted as early as possible in the project planning process for assistance in, and planning for, the interpretation of this performance-based Standard.

### Subsurface Injection

An operator can apply for approval to inject subsurface water into an underground formation, where the volume or quality of produced water makes surface disposal inappropriate (e.g., the water is highly saline). In this case, the operator must submit an application to the OGC, along with a Checklist for Approval to Dispose of Produced Water. A notice will be published in the BC Gazette allowing other subsurface owners 3 weeks to express any concerns with the proposed disposal program. The Commission will then review these concerns, along with the nature of the produced water and the receiving formation, and may issue an approval with any necessary conditions attached. Ongoing water injection requires the submission of a Monthly Injection/ Disposal Statement.

## DATA REPORTING AND CONFIDENTIALITY

A CBM experimental scheme allows for a longer time period of confidentiality of well data. Data from a given well on a scheme will be released 3 years after the OGC or MEM receives the well data or well report (section 57.4.e of the D&P Regulation). Similarly, test hole data is confidential for 3 years following the rig release date. For a conventional natural gas well, the confidentiality period ranges from 2 months to one year from the rig release date, depending on the well type (see Well Classification under Well Approvals).

The reporting requirements for CBM wells are essentially the same as those for conventional gas wells (see sections 49-57). For example, the Commission must be notified within 24 hours after drilling has commenced on a well (spud report), and wellbore drilling data, as contained in the Daily Reports, must be submitted. Copies of well logs must be provided within 30 days of being completed. An operator has 30 days from the rig release date to submit a Well History Report for exploration outpost or wildcat wells. Completion and Workover Reports must be provided within 30 days of the completion or workover operations. Other key drilling reports are listed under Operations Engineering Forms and Checklists (www.ogc.gov.bc.ca/formschecklists.asp).

# Gathering Systems and Pipelines

The design, construction, operation, maintenance and abandonment of gas gathering systems, pipelines, and compressor facilities must meet the requirements of the *Pipeline Act* and *Pipeline Regulation*, as well as various codes and practices (e.g., CSA Z662). A paramount concern is to ensure the safety and integrity of the pipeline or facility with respect to people and the environment. Approval of the OGC is required.

Applications for other production facilities must be submitted to the OGC under section 100.1 of the D&P Regulation. In addition, under *the Land Act*, the right to occupy public land for pipelines and facilities requires an application to the Commission, subject to a review process that is essentially the same as for well applications.

Compared to a conventional gas well, a CBM project typically involves low-pressure gas gathering lines. Several stages of compression may be required to reach pipeline pressures, which may result in more compressor stations and machines. Overall, the production site may be characterized by an extensive infrastructure of gas and water lines (often laid in the same trench), compressors, pumps, electricity feed lines, and other major equipment.

The OGC may consider gathering system and pipeline variances on a case-by-case basis. The Commission will need to be satisfied that safety is ensured in all cases. Proponents are urged to enter into discussion with the Pipelines contact early on in the planning process should a variance be anticipated.

As with a conventional gas well, a CBM operator must submit an Application for a Production Facility (BC-20) and an Application for a Well or Facility to Facility Linkage (BC-21). These forms cover production measurement (metering) and accounting, material handling, equipment spacing, air emissions, spill control measures, emergency response plans, production tracking linkages, and other information. Any proposals to vary from the standard requirements for conventional gas operations should be identified in the application process. CBM proponents are advised to notify OGC staff as early as possible of their proposed infrastructure, to allow a proper assessment of the design, safety, operational, and environmental impacts.

## METERING

The standard requirement for measuring production at gas wells is that each well must have its own meter unless otherwise approved by the Commission. This requirement has been relaxed for individual well measurement at some conventional wells when the applicant has provided evidence that the following conditions have been met:

- All wells involved have the same ownership.
- There is a common pool or all wells are part of an approved Unit.
- Royalty factors are equivalent for all wells.
- Group measurement with periodic well testing is undertaken to enable a reasonable allocation of product back to each well.

The same criteria will apply to an application to relax individual well metering for a CBM project. Again, any request to vary from the standard should be identified in the Facility Application, which should also include the proposed method for group measurement and allocation.

# Production

## CBM Zone/Formation

For any given conventional gas well, OGC geologists designate a specific pool and formation in which the well is located. A similar designation will be made for CBM wells.

Wells may be located in formations where both conventional and CBM potential exists. Section 41.1 of the D&P Regulation requires Commission approval for production from multi-zone wells. The OGC will regard production from multiple coal seams within a coal zone to be production from a common formation and will not require commingling approval. Production from CBM wells open to both coal and conventional reservoirs will be regarded as multi-zone or commingled production. Although the Engineering and Geology Branch will review each productive CBM well, proponents are expected to submit commingling applications as required. Should it be unclear as to whether a commingling application is required, the proponent is encouraged to contact the Branch (see CBM Zone/Formation contact) to discuss the situation.

## Off-target Penalties and Gas Allowables

Under section 10.5 of the D&P regulation, a conventional gas well completed outside the target area is subject to an off-target penalty. If the lease has more than one normal spacing area, one gas well may be completed in each area and no penalty will be assessed, as long as the designated setback is observed (section 10.4). Where the well is off-target, an operator must apply for a daily gas allowable, as per section 88.1.

It is not feasible to limit production at CBM wells. In order to be commercially viable, a well must operate at full capacity to complete the dewatering process and reach its full gas production.

Because of these unique characteristics, the OGC will not assign any gas allowables to CBM wells. Wells in off-target areas will not be allowed to produce unless a waiver is obtained from the affected tenure holder in question.

## Pressure Surveys

Reservoir pressure measurements are required on all producing natural gas pools in British Columbia, in accordance with section 95 of the D&P Regulation. All new conventional gas wells must have an initial static bottom hole pressure measurement, followed by an annual measurement of a portion of the wells in the producing pool.

In the case of CBM development wells, initial testing may yield non-representative pressures, since dewatering can take weeks or months. As a result, annual testing of all CBM wells in a given scheme is neither practical nor necessary.

For each CBM scheme, the Commission will require a representative initial pressure test, but will waive the requirement for annual testing. However, because a prudent CBM operator will want to obtain representative pressure measurements throughout production, it is recommended that periodic testing be conducted, preferably on observation or suspended wells in the scheme. The data from such testing can be useful for determining spacing and drainage needs.

Where pressure testing is conducted, all results must be reported to the OGC. Test reports, accompanied by the Reservoir Pressure Survey Test Report, must be submitted to the Commission's Victoria office within 60 days of completion of the test.

## Gas Well Tests, Injectivity Testing, and Gas Well Stream Analysis

Every conventional gas well is required to be flow tested and its absolute open flow (AOF) potential determined before the well has been producing for six months, as per section 84 of the

D&P Regulation. For a CBM well, however, peak levels of gas production may not occur until many months after the start of production, so that AOF testing is not meaningful. Therefore, the Commission will waive the requirement for gas well tests of CBM wells under the authority given by section 84(2).

Water injectivity and fall-off pressure tests can help determine the permeability of a CBM reservoir. This information, in turn, is useful in estimating the flow rates and ultimate gas recovery from the reservoir. Data on seam pressure and permeability are typically only needed for CBM exploration or delineation wells, to indicate the viability of a field. They are neither practical nor necessary for development wells. While the Commission does not require injectivity testing for CBM wells, the results of any tests that are performed must be submitted to the Commission's Victoria office within 60 days, with an attached Reservoir Pressure Survey Test Report.

Section 90 of the D&P Regulation requires that the fluids and gas produced from a natural gas well be analyzed at least once a year during the first 2 years of production and at other times requested by the Commission. The results, including the proportions of liquids and gas produced and a representative gas composition analysis, must be submitted to the Commission within 60 days of the testing.

Initially during production, a CBM well may produce mostly water and a mixture of gases (methane, carbon dioxide, nitrogen, and others). Since coal preferentially desorbs methane to carbon dioxide, gas composition will vary over the life of the well. To get a representative gas analysis may take considerable time in the case of CBM. It is appreciated that an operator will be motivated to obtain reliable gas analysis results and that data must be not only timely but of good quality. Consequently, the Commission will be flexible on the timing requirement for gas well stream analysis at CBM wells.

## DATA REPORTING

For any CBM experimental scheme, the operator will be required to submit a report every 6 months in the first year, and then annually thereafter, on the progress, performance, and efficiency of the scheme. The progress report will contain the following:

- The daily average rate of gas and water production during each month for each producing well, and for the scheme as a whole;
- The monthly cumulative gas and water production for each producing well, and for the scheme as whole;
- A representative sample analysis of produced water obtained once every 6 months;
- The date and type of any well treatment or workover for any well in the scheme;
- All information gathered to evaluate the CBM reservoir qualities such as gas content, desorption analysis, injectivity tests, and permeabilities of coal seams; and
- Any other information that is considered necessary, in the opinion of the Commission, to evaluate the progress, performance, and efficiency of the scheme.

These reporting requirements will be specified in the approval for the experimental scheme.

## ROYALTIES

On March 1, 2002, British Columbia introduced a new royalty for CBM containing the following provisions:

- Produced water handling costs are now included in the producer cost of service allowance, to cover the added water management costs;

- A royalty bank has been created to collect excess allowance for use against future assessed royalties;
- The low productivity royalty rate adjustment factor threshold is increased to 600,000 cubic feet per day from 180,000 cubic feet per day, to address the lower production rates; and
- A $50,000 royalty credit will be provided for CBM wells drilled by February 29, 2004.

# Abandonment and Restoration

## Plugging and Abandonment

Any well or test hole must not be left unplugged or uncased after it has served the purpose for which it was drilled (section 44.1 of the D&P Regulation). In the case of wells, cement is generally required to isolate the formation and prevent the flow of gas and water. Cement plugs, cutting and sealing of the well casing, and other requirements are specified in section 45.3 of the D&P Regulation. Prior to abandonment, an operator must submit an Application to Abandon a Well for Commission approval of the abandonment program. Sufficient information (e.g., logs) may be required to enable evaluation of the program's effectiveness.

Likewise, plugging programs for the abandonment of test holes require Commission approval, and some supporting information may be required.

## Surface Restoration

Before abandoning a well, test hole, or production facility, the operator must remove all equipment and waste materials, restore the land as closely as is reasonable to its original condition, and apply to the Commission for a Certificate of Restoration (section 48 of the D&P Regulation). The application must be accompanied by a *Waste Management Act* Site Profile, which is used to determine if a location may be contaminated. Where there is potential for contamination, further investigation of the site will be ordered and, if confirmed, any contamination must be remediated to the appropriate standards.

The Commission may issue the Certificate of Restoration when it is satisfied that the restoration is complete, or when the operator files a signed release from the landowner. For developments in the Agricultural Land Reserve, the Land Reserve Commission must confirm the restoration before a certificate can be issued.

# Attachment 1: Contacts

| Subject Area | Contact/Office | Phone |
|---|---|---|
| General CBM policy | Derek Brown, MEM (Victoria) | 250-952-0432 |
| Geophysical Exploration | Kelly Harrison (Fort St. John) | 250-261-5720 |
| Petroleum and natural gas rights | Petroleum Lands Branch, MEM (Victoria) | 250-952-0335 |
| Experimental schemes | Peter Attariwala (Victoria) | 250-952-0311 |
| Well authorizations | Devin Scheck (Fort St. John) | 250-261-5720 |
| Test holes | Devin Scheck (Fort St. John) | 250-261-5720 |
| Well spacing/site size | Bruce Cazes (Fort St. John)<br>Don Buckland (Fort St. John) | 250-261-5759<br>250-261-5761 |
| Surface casing/BOP | Don Buckland (Fort St. John)<br>Bruce Cazes (Fort St. John) | 250-261-5761<br>250-261-5759 |
| Equipment spacing/rig standards | Bruce Cazes (Fort St. John) | 250-261-5759 |
| Worker safety | Bud Phillips, WCB (Fort St. John) | 250-785-1283 |
| Samples/logs/cores | Jeff Johnston (Victoria) | 250-952-0355 |
| Flow testing/gas well tests | Ron Stefik (Victoria) | 250-952-0310 |
| Flaring | Richard Slocomb (Fort St. John) | 250-261-5763 |
| Data reporting and confidentiality | Peter Attariwala (Victoria) | 250-952-0311 |
| Gathering systems | George Holland (Fort St. John) | 250-261-5760 |
| Pipelines | Richard Caesar (Fort St. John) | 250-261-5790 |
| CBM zone/formation | Jeff Johnston (Victoria) | 250-952-0355 |
| Off-target penalties/gas allowables | Peter Attariwala (Victoria) | 250-952-0311 |
| Water disposal | Craig Gibson (Victoria) | 250-952-0294 |
| Pressure surveys/injectivity testing/ gas well stream analysis | Ron Stefik (Victoria) | 250-952-0310 |
| Royalties | David Molinski, MEM (Victoria) | 250-952-0518 |
| Abandonment and reclamation | Dave Krezanoski (Fort St. John) | 250-261-5762 |

# Attachment 2: Surface Casing, BOP, and Equipment Spacing

Consistent with the move to performance-based regulation, the OGC will apply minimum requirements to three cases for evaluation: Rank Exploratory, Initial Field Delineation, and Development of Defined Field. These requirements hold for both authorized wells and test holes. In all cases, operators are responsible for conducting the necessary research to justify their decisions and for having the supporting information available should the Commission choose to review it.

### Case 1: Rank Exploratory

If there is little or no drilling information for the immediate area, then the drilling program must follow the conventional D&P Regulation, as defined above (full Class A BOP stack, etc.).

### Case 2: Initial Field Delineation

When the CBM boundaries are not clearly defined and some uncertainty exists as to area geology, then the following minimum requirements apply and the operator must have supporting geological, drilling, and risk assessment information available to the Commission upon request:

Surface Casing

- Set minimum of 25 m into competent formation
- Pressure cement to the surface in the annulus
- Subsequent casings run to be cemented to surface (groundwater protection – shallow surface casing)
- Capable of holding the maximum allowable casing pressure (MACP) expected at the shoe
- Capable of supporting BOP system

Well Control Equipment Considerations (commensurate with anticipated pressures)

- Ability to close in on pipe (annular) from remote location
- A secondary method of closing in on open hole from a remote location
- Ability to hold pressure (shut in well) while retrieving core
- Ability to control well
  - Monitor hole fill trip tank and mud tank volume
  - Ability to monitor mud properties
  - Ability to degas mud if necessary
  - Manifold for choke line
  - Ability to read pressures
  - Rig personnel trained in blowout prevention and well control
- Ability to pump kill fluids
- Working spool (for kill and choke/flare lines)
- Ability to monitor for and detect gases

Wellsite Equipment Spacing

- Flare stack 50 m from wellhead
- Wellsite offices 25 m from wellhead, 40 m from flare stack
- Sleeping quarters 50 m from wellhead and flare stack

### Case 3: Development of Defined Field

The requirements set out in Case 2 Initial Field Delineation may be relaxed through risk assessment in development drilling situations where representative wells have been drilled in the area, geological control is known to be representative and accurate, and the proposed wells are clearly for CBM development only. Reference information supporting any application of this nature must be complete and available to the Commission upon request:

Surface Casing

- Must satisfy all requirements set out in Case 2, with the following exception
- May use pressure-cemented conductor set at a minimum of 15 m into competent formation

Well Control Equipment

- Must meet all requirements set out in Case 2, with the following exceptions
- May use Alberta Class 1A diverter system with the ability to remotely close in on pipe or open hole using annular
- Choke manifold not required
- Must be able to control well from surface at all times

Wellsite Equipment Spacing

- Must satisfy requirements outlined in Case 2 with the following exceptions
- Flare stack 25 m from wellhead
- Sleeping quarters 25 m from wellhead and 40 m from flare stack (wellhead gas detection with alarms in sleeping quarters are required in this situation)

In all cases, the operator is required to conform to the WCB requirements with respect to wellsite equipment spacing (*Workers Compensation Act*; *Occupation Health and Safety Regulation*, Part 23: Oil and Gas). As mentioned in the Well Spacing and Site Size section, the Commission continues to work with the WCB to development specification for reduced equipment separation distances that will be suitable for CBM projects.

For now, for any reductions from Case 1 Rank Exploratory (i.e., full adherence to the D&P Regulation), the operator must contact the WCB (see Contacts) to ensure compliance. All drilling programs should be designed and carried out by qualified and competent personnel.

## RIG STANDARDS

In some cases, CBM wells may be drilled using rigs and crews that are normally engaged in water well drilling or mineral coring. The Commission requires that both the equipment and personnel employed in a rig be capable to do the work of drilling a gas-producing well. Operators must ensure that their rigs meet the following requirements:

- Equipment certified for intended work (name plated)
- Hoisting capability to meet CAODC standards
- Equipment capable of drilling with drilling fluid and/or air
- Crew trained in working with natural gas
- Operations representative at wellsite with valid 2$^{nd}$ Line BOP Supervisors Certificate (PITS) and Rig Manager (toolpush) and Drillers with 1$^{st}$ Line BOP Supervisors Certificate (PITs)
- Sufficient crew to safely perform required tasks

Gas monitoring while drilling may be required.

# Attachment 3: Glossary

The following definitions relate to terminology as it is used in this document:

**Abandoned –** A well that is permanently closed off when it is depleted and no longer capable of producing profitably.

**Abandonment –** Converting a drilled well to a condition that can be left indefinitely without further attention and will not damage freshwater supplies, potential petroleum reservoirs, or the environment.

**Absolute open flow (AOF) potential –** Productive capacity at a gas well that is open to the atmosphere (zero backpressure).

**Annular –** A large doughnut-like valve used in a BOP stack that is mechanically squeezed inward to seal on the pipe.

**Blowout –** An uncontrolled flow of gas, oil, or other fluids from a well.

**Blowout Preventor (BOP) –** Equipment installed on the wellhead to prevent the escape of fluids under pressure from the wellbore during drilling, completion, or workover operations. The BOP stack incorporates different sets of hydraulic rams enabling shut in of the well with or without pipe in the hole, pumping of fluids into the well under pressure, and controlled release of fluids from the well.

**Borehole –** The wellbore; the hole made by drilling or boring a well.

**Bottom hole pressure –** The pressure in a well at a point opposite the producing formation.

**CAODC** – Canadian Association of Oilwell Drilling Contractors.

**Casing –** Steel pipe used in wells to seal the borehole from formation fluids and reinforce the walls of the borehole.

**Cavitation –** A mechanical method, usually with high-pressure water jets, of creating a cavity around the wellbore in a coal formation so as to increase the area of the coal exposed to the wellbore.

**Coalbed methane (CBM)** – The natural gas found in most coal deposits; formed during coalification, the process by which plant material is converted into coal over millions of years.

**Completed well –** A well that has had the necessary work done to enable production.

**Completion –** The process of finishing a well so that it is ready to produce gas.

**Compressor –** A machine used to boost natural gas pressure to move it through pipelines or other facilities.

**Core –** A cylindrical borehole sample for analysis of various properties of the formation, including porosity, permeability, fluid content, and geological age.

**CSA** – Canadian Standards Association.

**Delineation well –** A well that extends that boundary of a previously discovered pool.

**Desorption –** The process of detaching methane adsorbed onto coal by de-pressuring the coal seam through dewatering and other methods.

**Development well –** A well drilled in or adjacent to a proven part of a pool to optimize production.

**Dewatering –** The process of removing water from a coal seam in the vicinity of a producing gas well. Dewatering is required to reduce pressure within the coal seam, which in turn allows the methane gas to be released from the coal.

**Directional drilling –** A well drilled at an angle from the vertical. This method can be used when local topography (e.g., river banks or other water bodies) prevents vertical drilling. Under normal conditions, vertical drilling is used (i.e., the bottom of the hole is located beneath the drill rig).

**Diverter –** A device used to direct fluids flowing from a well away from the drilling rig.

**Drill pipe –** Steel pipe sections of about 9 m in length that are screwed together to form a continuous pipe extending from the drilling rig to the drilling bit at the bottom of the hole. Rotation of the drill pipe and bit causes the bit to bore through the rock.

**Drill-stem test –** A method of gathering data on the potential productivity of a formation before installing casing in a well. A drill stem test records pressure and fluid recovery data from which formation characteristics can be inferred.

**Exploratory well –** A well drilled in an unproven area where no oil or gas production exists nearby.

**Formation –** A designated subsurface layer that is composed throughout of substantially the same kind of rock or rock types.

**Flaring –** The burning of natural gas as a means of disposal. It is restricted primarily to short-term testing, well workovers, or exceedingly rare emergency situations.

**Fracturing –** The practice of pumping special fluids down the well under high pressure; hydraulic fracturing causes the formation to crack open, creating passages for the reservoir fluids to more easily flow into the wellbore.

**Gathering system –** The pipelines and other infrastructure that move raw gas from the wellhead to processing and transmission facilities.

**Kill –** To prevent the threatened blowout of a well or to stop a blowout in progress, usually accomplished by the pumping of heavy fluids under pressure into the wellbore to overbalance the formation pressure.

**Log –** A detailed depth-related record of geological, formation attribute, and hydrocarbon potential data obtained by lowering measurement instruments into a well.

**Observation well –** A non-producing well used to monitor pool pressure, usually included in annual pressure testing surveys.

**Open hole –** A wellbore in which casing has not been set.

**Perforate –** Make holes through the casing and cement opposite the producing formation to allow gas to flow into the well.

**Permeability –** The capacity of a reservoir rock to transmit fluids; how easily fluids can pass through rock.

**Porosity –** The volume of spaces within rock that might contain oil and gas (like the amount of water a sponge can hold); the open or void space within rock.

**Producer cost of service allowance –** An allowance against royalties to cover the costs of gathering and processing natural gas for sale, and the costs of conserving conservation gas.

**PVC –** Polyvinyl chloride.

**Reservoir (pool) –** A porous and permeable underground rock formation containing a natural accumulation of crude oil or natural gas that is confined by impermeable rock or water barriers, and is separate from other reservoirs.

**Resistivity –** The electrical resistance offered to the passage of an electrical current.

**Samples –** The wellbore drill cuttings obtained at definite depth intervals during drilling. These cuttings can be examined to determine the rock type, the formation being drilled, and indications of gas content.

**Shoe –** Steel reinforcement at the end of the casing string to protect against buckling or deformation as the casing is being lowered.

**Sour gas –** Natural gas containing hydrogen sulphide or other sulphur compounds.

**Spool –** A flanged joint placed between the blowout preventer and drilling valve, serving as a spacer.

**Surface casing –** The first string of casing put into a well; it is cemented into place and serves to shut out shallow water formations and as a foundation for well control.

**Suspended well –** A well that was previously completed, but is now no longer being produced.

**Tcf –** Trillion Standard Cubic Feet.

**Wellbore –** The hole made by the drilling bit.

**Wellhead –** The equipment used to maintain surface control of a well; formed of the casing head, tubing head, and surface valves.

**Well servicing –** The maintenance work performed on a well to maintain or improve production levels. Examples include repairs to pumps, valves, and tubing.

**Wildcat –** See Exploratory Well.

**Workover –** Additional work required on a well to maintain or improve production. Examples include wellbore flow simulation by perforating or fracturing and installing water pumps.

# Oil and Gas Commission Regulatory Process for Coalbed Methane Projects