

Management of Saline Fluids for Hydraulic Fracturing Guideline

VERSION 1.2: December 2023



About the Regulator

The BC Energy Regulator (Regulator) is the single-window regulatory agency with responsibilities for regulating oil and gas activities in British Columbia, including exploration, development, pipeline transportation and reclamation.



The Regulator's core roles include reviewing and assessing applications for industry activity, consulting with First Nations, ensuring industry complies with provincial legislation and cooperating with partner agencies. The public interest is protected by ensuring public safety, protecting the environment, conserving petroleum resources and ensuring equitable participation in production.

Vision, Mission and Values

Vision

A resilient energy future where B.C.'s energy resource activities are safe, environmentally leading and socially responsible.

Mission

We regulate the life cycle of energy resource activities in B.C., from site planning to restoration, ensuring activities are undertaken in a manner that:



Protects public safety and the environment



Supports reconciliation with Indigenous peoples and the transition to low-carbon energy



Conserves energy resources



Fosters a sound economy and social well-being



Values

Respect is our commitment to listen, accept and value diverse perspectives.

Integrity is our commitment to the principles of fairness, trust and accountability.

Transparency is our commitment to be open and provide clear information on decisions, operations and actions.

Innovation is our commitment to learn, adapt, act and grow.

Responsiveness is our commitment to listening and timely and meaningful action.

Additional Guidance

As with all Regulator documents, this document does not take the place of applicable legislation. Readers are encouraged to become familiar with the acts and regulations and seek direction from Regulator staff for clarification.

The Regulator publishes both application and operations manuals and guides. The application manual provides guidance to applicants in preparing and applying for permits and the regulatory requirements in the planning and application stages. The operation manual details the reporting, compliance and regulatory obligations of the permit holder. Regulator manuals focus on requirements and processes associated with the Regulator's legislative authorities. Some activities may require additional requirements and approvals from other regulators or create obligations under other statutes. It is the applicant and permit holder's responsibility to know and uphold all legal obligations and responsibilities. For example, Federal Fisheries Act, Transportation Act, Highway Act, Workers Compensation Act and Wildlife Act.

Throughout the document there are references to guides, forms, tables and definitions to assist in creating and submitting all required information. Additional resources include:

- [Glossary and acronym listing](#) on the Regulator website.
- [Documentation and guidelines](#) on the Regulator website.
- [Frequently asked questions](#) on the Regulator website.
- [Advisories, bulletins, reports and directives](#) on the Regulator website.
- [Regulations and Acts](#) listed on the Regulator website.

In addition, this document may reference some application types and forms to be submitted outside of the Application Management System but made available on the Regulator's website. Application types and forms include:

- Heritage Conservation Act, Section 12
- Road use permits
- Water licences
- Master licence to cut
- Certificate of restoration
- Waste discharge permit
- Experimental scheme application
- Permit extension application

Table of Revisions

The Regulator is committed to the continuous improvement of its documentation. The table below summarizes revisions to the Management of Saline Fluid for Hydraulic Fracturing Guideline. Revisions are posted to the documentation section of the Regulator’s website at the beginning of every month and are effective one month after posting, unless otherwise noted. For more information about the Regulator’s monthly revisions, and for details of this month’s revisions, please visit the [documentation section](#) of the Regulator’s website.

Stakeholders who would like to provide input or feedback on Regulator documentation may send comments to ServiceDesk@bc-er.ca.

Posted Date	Effective Date	Chapter	Summary of Revision(s)
April 11, 2019	May 1, 2019	Section 2.4 & 3.4	Changed “within 48 hours” to “immediately” when referring to the submission requirements for spills.

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Preface

About

The Management of Saline Fluid for Hydraulic Fracturing Guideline is a reference document for oil and gas permit holders detailing the requirements and expectations for siting, design, construction, operation, and decommissioning of lined containment systems used for the storage of saline fluids. These fluids are used in or returned to surface from hydraulic fracturing operations. These saline fluids include flowback from hydraulic fracturing operations, produced water, and saline source water. Where the term “saline fluids” is used throughout this guideline, it applies to each of these three types of fluid including any combination of these fluids as well as any combination of these three fluids that have been mixed with fresh water.

Lined containment systems are structures that use engineered synthetic materials (e.g., high-density polyethylene liners) as the primary means of containment to prevent fluids from contacting soil and groundwater. This includes lined in-ground earthen containment ponds and lined above-ground walled storage systems (AWSS), commonly known as c-rings.

For permit holders, the guideline provides an overview of their obligations under the Energy Resource Activities Act ([ERAA](#)), and the Environmental Management Act ([EMA](#)). It is intended as guidance for permit holders to demonstrate ongoing compliance with these acts and their supporting regulations with respect to the storage of saline fluids.

The guideline has been prepared to be as comprehensive as possible; however, it is not all encompassing and may not cover all site-specific situations. Where circumstances or scenarios arise and are not covered by the guideline, contact one of the Regulator’s Environmental Management and Reclamation staff members for assistance.

Guideline Structure

Beginning with planning considerations, this guideline provides references to the legislation that provide the basis for the management of saline fluids generated from and/or for use in hydraulic fracturing and provides other general considerations applicable to planning for a lined containment system.

Also captured are the requirements for AWSS design, construction, operation, monitoring and decommissioning, as well as the requirements for storage ponds used for saline fluids. The guideline is limited in scope to the Regulator’s application processes and the authorities and requirements established within the [Energy Resource Activities Act](#) (ERAA) or specified enactments established thereunder. Carrying out oil and gas and related activities may require additional approvals from other regulators or create obligations under other statutes. It is the permit holder’s responsibility to know and uphold all of their legal obligations.

Guideline Scope

This guideline is limited in scope to the regulatory provisions applicable to the storage and disposal of saline fluids found in the Energy Resource Activities Act ([ERAA](#)), Environmental Management Act ([EMA](#)), Contaminated Sites Regulation ([CSR](#)), Oil and Gas Waste Regulation ([OGWR](#)), Hazardous Wastes Regulation ([HWR](#)), Spill Reporting Regulation ([SRR](#)), Drilling and Production Regulation ([DPR](#)), and Environmental Protection and Management Regulation ([EPMR](#)). It is the permit holder's responsibility to know and uphold all of their legal obligations.

For a detailed list of the applicable regulatory provisions, see Chapter 1 of this document.

Additional Guidance

Additional BCER manuals and guidelines are available in the [documentation section](#) of the Regulator's website. The [glossary](#) page of the Regulator's website provides a comprehensive list of common terms, and ERAA and its regulations provide the primary source of legal definitions.

Compliance and Enforcement

This document does not replace legislation or affect legislative requirements. All permit holders are ultimately responsible for ensuring they understand and meet all requirements of the Energy Resource Activities Act and their permits. Should a person not comply with ERAA, the Regulator may take compliance and enforcement actions. For more information regarding the Regulator's Compliance and Enforcement processes, please refer to the Compliance and Enforcement Manual.

Chapter 1:

Pre-Application Planning Considerations

This section provides regulatory references to the legislation that provides the basis for the management of saline fluids generated from and/or for use in hydraulic fracturing and provides other general considerations applicable to planning for a lined containment system.

Regulatory provisions applicable to the storage and disposal of saline fluids are found in the following documents:

- Oil and Gas Activity act ([ERAA](#)).
- Environmental Management Act ([EMA](#)).
- Contaminated Sites Regulation ([CSR](#)).
- Oil and Gas Waste Regulation ([OGWR](#)).
- Hazardous Wastes Regulation ([HWR](#)).
- Spill Reporting Regulation ([SRR](#)).
- Drilling and Production Regulation ([DPR](#)); and
- Environmental Protection and Management Regulation ([EPMR](#)).

1.1 Energy Resource Activities Act

The Energy Resource Activities Act (ERAA) defines what constitutes oil and gas activity and is the primary legislation that governs oil and gas activity in the province of British Columbia. The Act itself contains requirements to minimize waste during the conduct of oil and gas activities (section 35) and requirements to prevent, report, contain, and eliminate spillage as well as to remediate land or water affected by spillage (section 37). The following regulations under ERAA are also relevant to fluid storage.

1.1.1 Drilling and Production Regulation

Section 50 (1) of the Drilling and Production Regulation requires permit holders to take every reasonable precaution to prevent loss or waste of oil, gas or water in drilling, producing and processing operations, and, in storing, piping or distributing, oil or gas must not be used wastefully, be allowed to leak or escape from natural reservoirs, wells, tanks, containers or pipes.

Section 51 (1) of the Drilling and Production Regulation prohibits completion fluids, formation water, oil, drilling fluid, wastes, chemical substances, and refuse from a well or facility from doing any of the following:

- 1) Creating a hazard to public health or safety.

- 2) Running into or contaminating any water supply well, usable aquifer or water body or remaining in a place from which it might contaminate any water supply well, usable aquifer or water body.
- 3) Running over, polluting or damaging any land or public road.
- 4) Passing into or, on ice, over any water body that is frequented by fish or wildlife or that flows into any such water body.

1.1.2 Environmental Protection and Management Regulation

Section 10 of the Environmental Protection and Management Regulation (EPMR) prohibits those conducting oil and gas activities on top of an aquifer from causing any material adverse effect on the quality, quantity, or natural timing of flow in the aquifer. Section 12 of the EPMR prohibits the deposition of deleterious materials into a stream wetland or lake.

1.2 Environmental Management Act

The Environmental Management Act (EMA) is primary provincial legislation that governs the introduction of wastes into the environment. It defines those discharges that require authorization and those exempt from requiring authorization. EMA also defines what constitutes contamination in soil, sediment, water, and groundwater across the province. Section 6 of EMA prohibits a person from introducing, causing, or allowing waste to be introduced into the environment from a prescribed industry or activity unless it occurs under permit, approval, or in accordance with a regulation under EMA. The oil and gas industry is a prescribed industry under the Waste Management Regulation of EMA and any unauthorized discharge of waste from oil and gas activities is a violation of EMA. The following regulations under EMA are also relevant to fluid storage.

1.2.1 Oil and Gas Waste Regulation

The Oil and Gas Waste Regulation (OGWR) provides authorization for the majority of temporary and low risk discharges associated with oil and gas activities. Section 7(1) of this regulation authorizes the deep well disposal of flowback fluids from hydraulic fracturing and produced water to deep underground formations via disposal wells that have been authorized by the Regulator. Section 5(2) of this regulation prohibits stored fluids from causing objectionable odors at the perimeter of the property.

1.2.2 Hazardous Waste Regulation

Hazardous wastes generated by the oil and gas industry are subject to the provisions of the Hazardous Waste Regulation. This includes requirements for the storage, transport, treatment, and disposal of hazardous wastes. This regulation is administered by the Ministry of Environment.

1.2.3 Spill Reporting Regulation

The Spill Reporting Regulation defines what constitutes a reportable spill and requires the person who had possession, charge, or control of a substance immediately before the spill to report the spill to Emergency Management BC at 1-800-663-3456.

1.2.4 Contaminated Sites Regulation

Environmental quality standards are used to determine whether contamination is present within environmental media. Provisions for contaminated site determination are presented in Part 5 of the Contaminated Sites Regulation (CSR). Under section 15(1) of the CSR, numerical standards must be applied to determine whether a site is contaminated. The applicable numerical standards selected based on land, water and sediment use for a site are compared with site investigation results.

As per section 11(3) of the CSR, a site may not be considered contaminated if the concentrations of all substances present at the site are not greater than local background concentrations. Protocol 4 [Determining Background Soil Quality] and Protocol 9 [Determining Background Groundwater Quality] may be used to determine local background concentrations of a substance.

Risk-based standards cannot be applied to determine whether a site is contaminated.

1.3 Additional Considerations

In addition to the requirements stated above, the permit holder must also consider the following, where applicable.

1.3.1 Wildlife and Migratory Birds

The Wildlife Act details the provincial regulatory requirements related to wildlife. Federal requirements related to migratory birds are detailed in the Migratory Birds Convention Act.

The Regulator does not oversee or regulate either of these Acts but expects that permit holders will implement reasonable measures to prevent wildlife and migratory birds from entering, landing in, or ingesting fluids from open topped storage tanks and containment ponds.

Methods that operators have implemented or considered to attain this objective include: fencing, netting, predator decoys, sound deterrents (predatory bird calls, distress calls, and noise cannons), mechanical distractions, and radar-controlled bird deterrents (i.e. LRADs).

1.3.2 NORM Management

Depending on water chemistry, there may be potential for scale to develop in storage facilities. Permit holders should regularly survey their facilities for NORM (naturally occurring radioactive material) and where necessary have a NORM Management Plan in place for the protection of workers. Permit holders must ensure that materials sent to landfill or for recycling comply with the requirements of EMA.

1.4 General Principles of Waste Management

The Regulator expects that permit holders will manage wastes produced from oil and gas activities in a manner protective of both the environment and wildlife. Permit holders should give due consideration to managing wastes in accordance with the sequential priorities listed below:

- 1) To prevent the creation of waste.
- 2) To minimize the volume of waste.
- 3) To minimize the toxicity of waste.
- 4) To re-use waste.
- 5) To recycle waste.
- 6) To treat and/or dispose of waste.

To help offset industrial fresh water demand, the Regulator supports efforts to re-use industrial and municipal waste waters for hydraulic fracturing operations. Produced water and completion fluid returns may be re-used for subsequent hydraulic fracturing operations. Once there is no longer any operational use for saline fluid it should be disposed of by means of a disposal well permitted by the Regulator.

1.5 Siting Requirements for all Storage Systems

When siting a storage system, the Regulator expects the permit holder will choose a location that will minimize the risk of environmental damage, including any threats to the integrity of the storage facility, the quality of the soils (permeability, stability, etc.), groundwater, surface water, the health of humans, animals and plants during the construction, operation, and decommissioning of the storage facility.

Storage facilities should not be constructed:

- 1) Within 200m of a water supply well or groundwater capture zone identified in the Integrated Land and Resource Registry, whichever is greater. This does not include water source wells permitted by the Regulator for oil and gas use.
- 2) On top of an aquifer or recharge area identified in the Integrated Land and Resource Registry.

Chapter 2:

AWSS Requirements

This chapter outlines the requirements for above-ground walled storage systems (AWSS), beginning with constructing the system through to operating, monitoring and decommissioning.

2.1 AWSS Design and Construction

The Regulator expects that the wall system of an AWSS will be designed and engineered to withstand the hydraulic pressure of the contents at full capacity. The design must be certified by a professional engineer in good standing with EGBC and meet the following requirements:

- 1) The Regulator recommends that the design include measures to ensure that synthetic liners are not damaged during the course of operations and provide for the collection and containment of spills from hoses or fittings during loading and unloading.
- 2) The synthetic liner of an AWSS must have a quality assurance/quality control (QA/QC) report from the manufacturer specifying the liner properties and its construction.
- 3) The Regulator recommends that the synthetic liner used for primary containment be at least 30 mil (760 μm) thick, have hydraulic conductivity of 10⁻⁷ cm/s or less and have properties (i.e. density, tensile strength, chemical resistance, tear resistance, puncture resistance) that are fit for the purpose intended and the conditions and temperature extremes encountered.
- 4) The permit holder must ensure and document that the ground surface preparation is acceptable prior to installation. Consideration should be given to site-specific conditions including the substrate stability and bearing capacity, slope and grade, surface conditions, and the need for a geotextile cushion.
- 5) For the protection of the AWSS, the Regulator recommends it is located on the lease to isolate it as much as practicable from drilling and fracturing operations and from vehicle traffic.
- 6) To prevent introduction of waste into the environment, the Regulator recommends that all fittings and hoses are non-leaking, the spill control devices are installed at fluid transfer points, and connections and overflow prevention measures implemented.

2.2 AWSS Operation

Before directing completion flowback fluids or produced water into an AWSS, flow must first be directed through a pressurized separator to remove gas and liquid hydrocarbons. The flow may then be directed to other equipment in order to perform additional treatment and reduce the fluid temperature.

The following requirements must be met:

- 1) A minimum of 0.50 m freeboard must be maintained within an AWSS at all times.
- 2) Each AWSS must be inspected and monitored daily for leaks and the results of the inspections must be documented.
 - a) Leakage suspected to have come through the liner must be reported to the Regulator within 24 hours of discovery.
 - b) Results of the inspections must be maintained until the site is reclaimed.

2.3 Secondary Containment for AWSS

2.3.1 Short-Term Above Ground Storage

The Regulator recommends that all above ground storage systems including ASTs and AWSSs are located in a place and manner to ensure that fluids will not escape from the site in event of a failure. Berms or dikes may surround the entire site or may surround the tank(s) only.

Such containment is considered sufficient for short term storage (less than 1 year) of saline fluids where the effective capacity of each storage tank is less than 6600m³ and the structure is monitored daily for water level, freeboard, and leakage.

Please Note:

An AWSS is not considered to be the same as an above ground storage tank (AST) and is not considered appropriate for permanent storage.

2.3.2 Long-Term Above Ground Storage

If the use of the storage site is to exceed one year, or if the site conditions or monitoring actions are not in accordance with section 2.2 of this document then:

- 1) There must be a synthetically lined secondary containment system surrounding the AWSSs that is designed and maintained to be capable of holding a minimum of 110 per cent of the fluid in the largest AWSS, and
- 2) An AWSS will not be situated at a site unless the follow exists between the base of the pond and any aquifer or underlying bedrock:
 - a) A natural confining geologic unit a minimum of 5m thickness having an in-situ saturated hydraulic conductivity of 10⁻⁶cm/s or less;

- b) An engineered compacted clay liner providing a barrier of no less than 30cm thickness (measured perpendicular to the slope) with in-situ saturated hydraulic conductivity of 10⁻⁷cm/s or less; or
- c) Some other engineered solution such as a composite liner that achieves equivalent performance.

2.4 Spillage from an AWSS

Spills that are reportable under the Spill Reporting Regulation must be reported immediately to Emergency Management BC at 1-800-663-3456.

Any leakage suspected to have come through the liner of an AWSS must be promptly reported to the Regulator as per section 37(1)(b) of ERAA.

2.5 Decommissioning an AWSS

An AWSS is not intended for long-term use. Where the service life of an AWSS does not meet the siting and secondary containment requirements per section 2.3.2 of this document should not exceed 1 year, at which time the Regulator expects that the AWSS will be dismantled and removed from the site and the liner recycled or disposed of. The Regulator expects that the following requirements will also be met:

- 1) The service life of an AWSS that has secondary containment per section 2.3.2 of this document will not exceed the engineered design life of the liner.
- 2) Liners will not be re-used and will be recycled or disposed of at a disposal facility approved under the Environmental Management Act to accept such wastes (i.e. secure landfill).

Upon dismantling an AWSS the Regulator expects the operator will complete a cursory survey of the soils below the AWSS to determine the presence of any residual contamination. Where residual contaminants are identified it must be reported to the Regulator and managed as spillage per section 37 of ERAA.

Chapter 3:

Containment Pond Requirements

This chapter outlines the requirements for containment ponds, beginning with constructing the system through to operating, monitoring and decommissioning.

Containment ponds may be used to contain saline fluids provided they are constructed with multiple low permeability synthetic liners with leak detection and monitoring to demonstrate the fluids are not escaping to or impacting the environment.

The use of unlined containment ponds for the purpose of storage for saline fluids is prohibited under both ERAA and EMA.

Please Note:

Sections 1.5.2, 3.1, and 3.2 of this document are not retroactively applicable to existing facilities.

3.1 Siting of Containment Ponds

When siting a containment pond, the Regulator expects that the permit holder will choose a location that will minimize the risk of environmental damage, including any threats to the integrity of the storage facility, the quality of the soils (permeability, stability, etc.), groundwater, surface water, the health of humans, animals and plants during the construction, operation, and decommissioning of the storage facility. The Regulator expects that the permit holders will also adhere to the following requirements:

- 1) The permit holder will have a site specific response plan that will ensure the protection of groundwater resources at the site in the event of a failure of the liner system.
- 2) The site will not be situated where one or more of the following conditions exists:
 - a) The area is situated within a ravine, coulee, or gully.
 - b) The area is within a 200 year floodplain.
 - c) The area is within 100m of the normal high-water mark of a stream or natural body of water.
- 3) Containment ponds will not be situated at a site unless the follow exists between the base of the pond and any aquifer or underlying bedrock:
 - a) A natural confining geologic unit a minimum of 10m thickness having an in-situ saturated hydraulic conductivity of 10-6cm/s, or less; or
 - b) An engineered compacted clay liner covering the entirety of the base and walls of the pond and providing a barrier of no less than 60cm thickness (measured perpendicular to the slope) with in-situ saturated hydraulic conductivity of 10-7cm/s, or less; or

- c) Other engineered solution(s) such as a composite liner that achieves equivalent performance.
- 4) A geotechnical investigation of the site and a global stability analysis of the structure will be completed by a professional engineer in good standing with EGBC. The engineer must attest that the analysis completed is appropriate for and adequately represents the conditions expected to be present during the operation of the site, the structure is considered to be stable in accordance with standard engineering principles. The Regulator recommends that the facility have a minimum safety factor of 1.5 for any long-term condition.

3.2 Containment Pond Design and Construction

A lined containment pond may be used to store saline fluids only if it has been explicitly authorized through a facility permit approval under the Energy Resource Activities Act.

The design must be certified by a professional engineer in good standing with Engineers and Geoscientists BC (EGBC) and meet the following requirements:

- 1) The construction of the containment pond must be overseen by a professional engineer who can certify that the ground preparation, sub-drain system, liners, and interstitial monitoring system have been constructed in accordance with the design.
- 2) Construction of earthworks should only be done under non-frozen conditions. Where earthworks are intended to be undertaken during frozen conditions, the application must include details of measures to be taken during construction to ensure the structure will meet the design criteria.
- 3) The synthetic liners must be tested for integrity and have quality assurance/quality control (QA/QC) reports from the manufacturer specifying the liner properties and construction.
- 4) The design must include measures to ensure that synthetic liners are not damaged during the course of operations. The design must also provide for the collection and containment of spills from hoses or fittings during loading and unloading.
- 5) The primary synthetic liner must be a minimum of 60 mil (1.5 mm) thick, have hydraulic conductivity of 10⁻⁷cm/s or less and must have properties (i.e. density, tensile strength, chemical resistance, tear resistance, puncture resistance) that are fit for the purpose intended and conditions and temperature extremes encountered.
- 6) The secondary synthetic liner must be a minimum of 60 mil (1.5 mm) thick, have hydraulic conductivity of 10⁻⁷cm/s or less and must have properties (i.e. density, tensile strength, chemical resistance, tear resistance, puncture resistance) that are fit for the purpose intended and conditions and temperature extremes encountered.
- 7) The two liners must be separated by an engineered seepage system that maintains an interstitial space between the liners and prevents the liners from direct contact with each other.
- 8) The design must incorporate a leak detection system within the engineered seepage pathway leading to at least one leak detection well, vault, or port. This must allow for water

sampling from the lowest point of the pond, positioned between the primary and secondary liners and be designed for accurate measurement of leakage rate.

- 9) The design must incorporate a sub-drain below the secondary liner with an engineered seepage pathway (i.e. weeping tile) leading to at least one leak detection well, vault, or port. This must allow for water sampling from the lowest point of the excavation, positioned below the secondary liner and be designed for accurate measurement of leakage rate.
- 10) The Regulator recommends that the interstitial monitoring system and sub-drain monitoring system be designed to avoid perforation of the liners below the maximum fluid elevation level of the pond.
- 11) Both the interstitial monitoring system and the sub-drain monitoring system must be constructed so that accumulated fluids may be pumped out.
- 12) To prevent introduction of waste into the environment, fittings and hoses must be non-leaking, spill control devices must be installed at fluid transfer points and connections, and overflow prevention measures implemented.
- 13) The site must have adequate fencing to prevent wildlife access.

3.3 Containment Pond Operation

Containment ponds must be operated in accordance with ERAA and EMA. The following section outlines the requirements that must be met to ensure the integrity of the environment is upheld.

- 1) The pond must be constructed and bermed in a manner that does not allow surface runoff from the site to enter the pond. A minimum of 1.0 m freeboard must be maintained within the containment pond at all times.
- 2) Before directing completion flowback fluids into a containment pond, the flow must first be directed through a pressurized separator to remove gas and liquid hydrocarbons. The flow may then be directed to other equipment in order to perform additional treatment and reduce the fluid temperature.
- 3) The Regulator recommends that the primary containment liner be regularly inspected for evidence of leaks and damage and that records of issues related to inspections and corrective actions be maintained.
- 4) The service life of the storage pond must not exceed the design life of the liner.
- 5) The fluids within the leak detection system and sub-drain must be pumped out on a daily basis or as necessary to maintain the interstitial space and the sub-drain as free of fluid as practical. This may involve the use of an automated pumping system. The permit holder must maintain a record of the daily volumes pumped from the interstitial space and the sub-drain system.
- 6) A groundwater monitoring program must be developed by a qualified professional to evaluate potential groundwater impacts that could be associated with the pond. Monitoring wells must be used to establish baseline conditions for groundwater levels and chemistry prior to use of the containment pond and the baseline monitoring must include all parameters described in section 3.2.8 of this document.
- 7) Samples from the leak detection system and sub-drain must be collected and analyzed on a weekly basis. The Regulator recommends that analysis be conducted in the field by operational personnel and should include pH and chlorides.

- 8) Samples from the leak detection system and sub-drain and groundwater monitoring wells must be collected and analyzed on a quarterly basis. The analysis must be conducted by an accredited laboratory and include pH, electrical conductivity, TDS, major ions including Ca, Mg, Na, K, NO₃, SO₄, Cl, Br, PO₄, BTEX, EPH(10-19), EPH(19-32), and CSR metals. Once the baseline conditions have been established for the monitoring wells (the Regulator recommends a minimum of 2 sampling events performed prior to use of the pond), the groundwater monitoring program may be revised upon recommendation from a qualified professional and accepted by the Regulator. After the first year of interstitial and sub-drain characterization is completed, the frequency of laboratory characterization may be reduced to an annual basis unless results of the field analysis in section 3.2.7 of this document indicate a need for additional characterization.
- 9) A summary of the information collected under sections 3.4.6, 3.4.7, and 3.4.8 of this document must be submitted to the Regulator annually by March 31.

3.4 Leakage from a Containment Pond

Spills that are reportable under the Spill Reporting Regulation must be reported immediately to Emergency Management BC at 1-800-663-3456.

Any leakage through the synthetic liners of a containment pond and into the native soil must be promptly reported to the Regulator as a spill per section 37(1)(b) of the *ERAA*.

- 1) The permit holder should calculate an action leakage rate for each containment pond. The action leakage rate (ALR) is defined as the amount of leakage that would occur through the primary liner of a dual lined system, based on two (2) holes per hectare each with a diameter of 2mm. Where the pond is operated at less than capacity, the action leakage rate should be calculated to account for actual operating conditions. The ALR should be calculated for each depth of water in 0.5m increments and the closest increment to the average daily level of the pond should be used for daily comparison of ALR.
- 2) Flow through holes in a single geomembrane liner may be calculated in accordance with Giroud and Bonaparte (1989) as follows:
 - a) $Q=C_b a(2gh_w)^{1/2}$
 - b) Q – leakage rate (m³/s)
 - c) C_b – dimensionless coefficient 0.6 for sharp edges (default value)
 - d) a – hole area (m²)
 - e) g – gravity (m/s²)
 - f) h_w – depth of liquid (m)
- 3) Any leakage through the primary liner in excess of the action leakage rate for a period of 3 consecutive days or more; or any indication of leakage through the secondary liner characterized by chloride levels in excess of the drinking water standard (250mg/L) within the sub-drain, must be reported to the Regulator by email at waste.management@bc-er.ca using the subject line “Liner Leakage Report” within 24 hours of discovery and the permit holder must take remedial actions as necessary.

3.5 Decommissioning a Containment Pond

Upon decommissioning a synthetically lined earthen containment pond, a qualified professional must complete an environmental investigation to evaluate the presence of residual contamination and the report must be submitted to the Regulator. Where residual contaminants are identified, the permit holder must submit a remedial action plan with timelines along with the investigation report.

Liners must not be re-used and may be recycled or disposed of at an approved disposal facility.