



Ministry of  
Environment

*PROTOCOL 14*  
**FOR CONTAMINATED SITES**

Requirements for Determining  
Barite Sites

Prepared pursuant to Section 64 of the  
*Environmental Management Act*

Approved: Signed by J. E. Hofweber  
Director of Waste Management

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Date

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## 1.0 Definitions

“**anthropogenic barium**” means any form of barium present, stored, used, or disposed of at a site by humans.

“**barite**” means the chemical compound, barium sulphate ( $\text{BaSO}_4$ : CAS No. 7727-43-7, 13462-56-7).

“**barite site**” means a site at which it can be demonstrated to the satisfaction of the Director that anthropogenic barium at the site is exclusively in the form of barite.

“**contaminated sites legal instrument**” includes; but is not limited to, a Determination, Approval in Principle, Certificate of Compliance, Contaminated Soil Relocation Agreement, Remediation Order, and Voluntary Remediation Agreement, as defined in the *Environmental Management Act*.

“**Director**” means the Director under the *Environmental Management Act*.

## 2.0 Introduction

The toxicity of barium is attributed to the barium ion ( $\text{Ba}^{+2}$ ) and therefore the toxicity of a particular barium compound is related to that compound's solubility. Although in general the solubility of barium compounds increases with decreasing pH, barite (barium sulphate) is virtually insoluble in alcohol, alkalis and weak or dilute acids. Consequently barite is unique among barium compounds in being virtually insoluble and non-toxic under most environmental conditions.

The ministry provides two analytical methods for the analysis of barium in soil:

- Strong Acid Leachable Metals (SALM) in Soil [1], and
- Analytical Method 9 – Soluble Barium by Calcium Chloride Extraction [2].

At sites where barium has only been used in the form of barite for commercial or industrial purposes, the SALM analytical method can result in considerable overestimation of soluble barium concentrations in soil when compared to more environmentally relevant extraction methods. To address this issue of extractive bias related to barite, the Director approved Analytical Method 9 for use at barite sites. This new method is based on calcium chloride cation exchange-associated extraction of barium from soil rather than the traditional strong acid extraction used in SALM. Compared to SALM, the calcium chloride method is much less “aggressive” in its ability to extract barium from barite in soil. However, Analytical Method 9 will efficiently extract barium from other more soluble, and therefore more toxic, barium compounds which may be present in soil.

At any site, including barite sites, barium concentrations in soil may be determined using the SALM method. Analytical Method 9, however, has been designed and validated strictly for use at barite sites.

The purpose of this protocol is to provide a procedure by which a site may be determined to be a barite site, and to specify associated rules of application related to the use of Analytical Method 9 at such sites.

### **3.0 Determination if a site is a barite site**

For the purposes of this Protocol, a site may be determined to be a barite site based on evidence that demonstrates to the satisfaction of the Director that the sole anthropogenic source of barium at the site can be attributed to barite. Examples of acceptable documentary evidence include, but are not necessarily limited to:

- invoices, bills of sale, bills of lading, receipts, and other financial records;
- well drilling (Tour) reports<sup>1</sup>;
- daily well drilling records and well logs;
- contractor service invoices and receipts;
- BC Oil and Gas Commission drilling Waste Disposal Summary forms or other waste disposal information on record<sup>2</sup>;
- well installation, maintenance and decommissioning records (well files);
- records provided, reviewed or assessed in environmental consultant site reports; and
- records provided, reviewed or assessed in other pertinent company or government (Federal, Provincial or local) reports.

The provision of complete, documentary evidence related to the determination of a site as a barite site is the responsibility of the person undertaking investigation and/or remediation of the site.

### **4.0 Rules of application related to the use of Analytical Method 9**

The use of Analytical Method 9 to characterize barium concentrations in soil under the Contaminated Sites Regulation is authorized only at a site determined to be a barite site.

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<sup>1</sup> Tour reports, notification forms and daily drilling records may be obtained from IHS RapiData™, at <http://www.ihs.com>

<sup>2</sup> The BC Oil and Gas Commission may also be able to provide Tour reports, notification forms and daily drilling records. In addition, the BC Oil and Gas Commission maintains a drilling waste tracking system that may be accessed at [https://quoll.ogc.gov.bc.ca/generic\\_ogc/Ext\\_Accnt.Logon](https://quoll.ogc.gov.bc.ca/generic_ogc/Ext_Accnt.Logon)

Use of the SALM method to characterize barium concentrations in soil is authorized at all sites, including sites determined to be barite sites for which a person decides not to characterize barium concentrations in soil by using Analytical Method 9.

A person who decides to use Analytical Method 9 to characterize soil barium concentrations must also determine representative soil background barium concentrations<sup>3</sup>.

## **5.0 Reporting**

### **5.1 Reporting requirements**

Documentary evidence related to the determination of the site as a barite site must be provided in the preliminary site investigation report prepared for the site and submitted in support of applications for contaminated site legal instruments under the Regulation.

### **5.2 Reporting requirements related to barium in background soil**

A preliminary site investigation report prepared for a barite site must include representative soil background barium concentration data. The sampling requirements for background barium soil data are as follows:

- select three different background locations within the immediate locale of the barite site,
- at each background location collect a minimum of four soil samples consisting of:
  - one surface soil sample, obtained from 0 m to 0.1 m from the surface of the background location;
  - one shallow subsurface soil sample obtained from 0.5 m to 0.6 m from the surface of the background location;
  - one intermediate subsurface soil sample obtained from 0.9 m to 1.0 m from the surface of the background location; and
  - one deep subsurface soil sample obtained from 1.5 m to 2.0 m from the surface of the background location<sup>4</sup>,
- split each collected sample into equal parts, and
- analyze one part using the SALM in soil method and the other part using Analytical Method 9.

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<sup>3</sup> Currently, the ministry lacks regional or local background soil barium estimates determined by the new CaCl<sub>2</sub> methodology.

<sup>4</sup> Where geological conditions would allow doing so.

The background soil barium concentrations obtained for the 24 samples form a component of the preliminary site investigation report for the barite site.

## **6.0 Contaminated Soil Relocation Agreements for barite sites**

For the purposes of relocating contaminated soil under the provisions of section 55 of the *Environmental Management Act* and Part 8 of the Contaminated Sites Regulation, barium concentrations in soil determined at both the source and receiving sites, which are the subject of a Contaminated Soil Relocation Agreement, must have been analyzed using identical analytical methods.

## **7.0 References**

1. BC Ministry of Environment. (2007a). Strong Acid Leachable Metals (SALM) in Soil – Performance Based Method (PBM). In: British Columbia Environmental Laboratory Manual: 2007 – For the Analysis of Water, Wastewater, Sediment, Biological Materials and Discrete Ambient Air Samples. Environmental Quality Branch, Environmental Protection Division, Victoria, BC. April 2007. Available at: [British Columbia Laboratory Methods Manual](#)
2. BC Ministry of Environment. (2007b). Analytical Method 9 for Contaminated Sites. Soluble Barium by Calcium Chloride Extraction, Environmental Management Branch, Environmental Protection Division, Victoria, BC September 20, 2007. Available at: [http://www.env.gov.bc.ca/epd/remediation/analytical\\_methods/pdf/analytical\\_method\\_9.pdf](http://www.env.gov.bc.ca/epd/remediation/analytical_methods/pdf/analytical_method_9.pdf)

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