TABLE OF CONTENTS

1.0 Definitions

In this chapter of the Oil and Gas Handbook, the following terms have the attached meaning:

"**Accredited laboratory**" means a laboratory that has Canadian Association for Environmental Analytical Laboratories or Standards Council of Canada certification;

"ALC" means the Agricultural Land Commission;

"ALR" means all land within the Agricultural Land Reserve;

"Approved field testing methods" mean any method approved by the Manager, or a Director, and includes the use of Ion Selective Electrode technology providing that the equipment is calibrated according to manufacturers specifications and that the methods are supported by an ongoing QA/QC program. Records from the QA/QC program shall be maintained for a minimum of 5 years and shall be made available to OGC staff upon request;

"Authorized commission employee" means an OGC employee holding the position of Senior Waste Management Officer or Manager;

"Chapter" means the Drilling Waste Management chapter of the British Columbia Oil and Gas Handbook;

"CSR" means the Contaminated Sites Regulation under the *Environmental Management Act* of British Columbia;

"Director" means a Director of the *Environmental Management Act;*

"HWR" means the Hazardous Waste Regulation under the *Environmental Management Act* of British Columbia;

"Manager" means the Manager of Oil and Gas Waste Management, OGC;

"MoE" means the Ministry of Environment;

"OGC" means the Oil and Gas Commission;

"OGWR" means the Oil and Gas Waste Regulation under the *Environmental Management Act* of British Columbia;

"Operator" means the owner responsible to the commission for the drilling, completion, production and abandonment of a well or test hole and includes any contractor, subcontractor, consultant or subconsultant conducting work on behalf of the Operator.

2.0 Drilling Waste Containment

This section outlines the requirements for the construction of sumps used for the storage or handling of drilling wastes. Sumps are earthen excavations used to store drilling waste, including drill cuttings and cement returns. Alternative storage systems shall be used on sites that do not meet all the criteria listed under section 2.1. For each sump, the Operator must maintain a record as proof that the sump was constructed in accordance with the criteria detailed in this Chapter. This record shall include the names of both the company and the individual who assessed the sump to determine suitability, and any analytical parameters (i.e. particle size analysis) used to determine suitability. This record shall be made available at the request of the OGC.

Alternative storage systems include, but are not limited to:

1. tanks;
2. sump with an impermeable synthetic liner; or
3. an alternative storage system approved in writing by the Manager.

All drilling waste contained in a sump or alternative storage system shall be disposed of in accordance with all the requirements in the OGWR and this Chapter.

Only drilling waste, drill cuttings, and cement returns shall be placed in sumps. Sewage or other oilfield wastes shall not be mixed with the drilling waste. Precipitation landing within a sump shall be managed as drilling waste.

Drilling waste that has been contaminated by sewage or other oilfield wastes is not authorized for disposal under this Chapter of the Handbook. In such cases, site specific approval from the Manager is required.

2.1 Sump Construction Requirements

1. Sumps shall only be constructed in undisturbed soil deposits that have suitable soils free of hydraulic defects, such as gravel lenses, silt lenses, sand lenses, cracks, fissures and root channels that impact the fluid containment capabilities of the sump. Sumps shall not be constructed in fill material unless site-specific sump design and construction methods have received written approval from an authorized commission employee.

2. Prior to use of a sump, the Operator shall ensure that a qualified person has performed an inspection and gathered sufficient lithology data to confirm that the in situ soil deposit consists of appropriate material, free of hydraulic defects that would impact fluid containment capability, and that the deposit extends a minimum of one metre beyond the horizontal and vertical dimensions of the sump. The investigation shall also verify that the seasonally high groundwater table is not within one metre of the base

of the sump. Appropriate material for the in situ soil deposit is defined as a clayey deposit that meets the following parameters:

a) equal to or greater than 40 per cent fines (0.075mm or smaller as determined by hydrometer method, or dry weight percentage passing the No. 200 sieve);

b) equal to or greater than 28 per cent clay (0.002 mm or smaller as determined by hydrometer method).

3. If, based on a field investigation, a qualified person determines that a sump is suitable, representative soil samples shall be collected and submitted for particle size analysis at an accredited laboratory within 48 hours. The number of samples taken shall be as many as required to account for any observed variation in soil texture across the site (minimum of one representative soil sample). If the qualified person performing the inspection notices any change in soil texture across the clayey deposit, one of the representative samples submitted for analysis shall be the coarsest textured soil that was encountered. Any sump that is determined to be suitable by a qualified person may be used prior to receiving confirmation from the laboratory analysis that the clayey deposit meets the particle size requirements listed in item 2. Should any of the representative samples indicate that the sump has been constructed in a location that does not meet the requirements of item 2, the Operator shall:

   a) immediately cease use of the unsuitable site for the management of drilling waste, remove all drilling waste from the unsuitable location and properly dispose of the drilling waste, or find alternative means of storage; or

   b) demonstrate to the satisfaction of the Manager that, based on further investigation and the recommendations of an environmental professional, adequate containment exists for the type of waste and duration of storage.

4. For the purposes of items 2 and 3, a qualified person is a person who:

   a) is employed/contracted by the Operator (i.e. responsible to the Operator);

   b) knows and understands the requirements for sump construction that are detailed in this Chapter;

   c) has been trained to accurately determine soil texture in the field to predict sump suitability;

   d) understands how to take proper representative soil samples and submit them to a laboratory following standard chain of custody procedures;

   e) can reasonably be relied upon to perform the investigation and sampling detailed in items 2 and 3.

5. Sump construction, storage of drilling waste, and disposal of drilling waste shall comply with Section 72 of the Drilling and Production Regulation. http://www.qp.gov.bc.ca/statreg/reg/P/PetNatGas/PetNatGas362_98/362_98.htm

6. As soon as reasonably possible after construction the Operator shall ensure that the OGC drilling waste tracking system has been used to accurately describe the location of the sump, type of drilling waste stored and wells contributing drilling waste to the sump. This must occur prior to the disposal of any drilling waste from a sump. The drilling waste tracking system will generate a sump number; which shall be prominently displayed at the site entrance of any remote sump until the site has been decommissioned.

   If there is a technical problem with the drilling waste tracking system that prevents the Operator from recording this information prior to disposal of drilling waste, the Operator may carry out the disposal activity if:

   a) it meets all other applicable requirements in this Chapter;
   b) the Operator has notified an authorized commission employee in writing (email is acceptable); and
   c) the above data is entered into the drilling waste tracking system within fourteen days after the technical problem has been fixed.

7. For the purpose of holding drill cuttings (not fluids) from water-based drilling operations only, above ground containment shall be constructed using soils that have:

   a) equal to or greater than 40 per cent fines (defined as dry weight percentage passing the No. 200 sieve); and
   b) equal to or greater than 28 per cent clay (0.002 mm or smaller as determined by hydrometer method); provided that:
      i. the containment cell has been constructed and soils compacted in a manner that will not allow any fluid (precipitation) to escape containment during the use of the cell (capacity needs to account for precipitation) and this is verified by inspection of a qualified person as described in section 4; and
      ii. the Operator establishes and maintains an inspection program to ensure the integrity of containment, giving due consideration to environmental conditions. This program shall be made available to OGC employees upon request; and
      iii. the location of the containment cell has all-season access; or

iv. if the location of the containment cell does not have all-season access, the drill cuttings must be disposed of within 30 days of rig release unless otherwise approved by an authorized commission employee.

2.2 Decommissioning of Drilling Sumps

Drilling sumps shall be decommissioned as soon as reasonably possible following rig release from the last well to contribute drilling waste to the sump.

Any earthen pit used to store drilling waste that has been constructed and maintained in accordance with the Sump Construction Requirements detailed in this Chapter, and has been designed and is maintained in a manner that will prevent domestic livestock and ungulates from ingesting sump fluids and drilling waste, is authorized to remain open for a period not to exceed 12 calendar months without further written approval from an authorized commission employee.

The Operator shall establish a monitoring and maintenance program for any sump that will remain open through any seasonal change (i.e. winter to spring) to ensure that adequate containment is maintained. The Operator shall provide details of the monitoring program if requested by an OGC employee. Any accidental release of drilling waste from a sump shall be reported to the Manager within 24 hours of discovery.

An authorized commission employee may, at any time, require further analysis if deemed necessary, or, as detailed in Section 96 of the *Petroleum and Natural Gas Act*, may specify or limit operations (including ordering the closure of any earthen pit) for any reason, including but not limited to:

1. the protection of life, property and wildlife; or
2. the prevention of pollution of water, air or land.

An Operator wishing to maintain a sump for a period in excess of 12 months shall apply to the OGC for approval and may be required to perform further field investigation to demonstrate that the site provides adequate containment and environmental protection for the type of drilling waste that is being stored.

Sumps shall be decommissioned in such a manner that subsidence does not result in a depression that may collect surface water. Sumps shall be decommissioned in a manner that does not result in the upward migration, through the soil profile, of salts and other substances from the soil:waste mixture. Upon decommissioning, all disturbed areas shall be vegetated to a self-sustaining cover as a method for erosion control and site stabilization.

Upon closure, any drilling sumps constructed within the Agricultural Land Reserve must meet the standard reclamation requirements (Schedule B) of the Delegation agreement between the ALC and OGC.
http://www.ogc.gov.bc.ca/documents/informationletters/Delegation Agree Final for Signature Jan 2004.pdf

3.0 Determining Suitability of Drilling Waste Disposal Sites

3.1 Introduction

The criteria detailed in this Chapter have been developed in consultation with MoE and with participation from industry through a Canadian Association of Petroleum Producers working group. The OGC and MoE were included in the Alberta D-50 review process as observers and the Handbook has been developed to take an approach to salinity management that is consistent with recommendations made during this process but modified to account for applicable British Columbia legislation and regulation. The Handbook will undergo periodic review to determine the effectiveness and suitability of the requirements. Post disposal reports will provide data from which the salinity criteria and sampling requirements can be evaluated and, if necessary, revised.

3.2 Receiving Soil Sampling

Background soil conditions must be assessed to determine whether a site is appropriate to receive drilling wastes and then used to predict whether the soil:waste mix will meet the endpoints set out in Tables 1, 2 and 3. In some circumstances, the resulting soil conditions must be re-evaluated upon completion of the disposal activity and hence, the depth of each pre- and post-disposal subsample must be representative of the soil:waste mixing depth for the specific type of disposal.

1. The assessment of soil conditions is related to the disposal method and, as a minimum, must consist of the following:

    a) For pump-off disposals, samples to assess pre- and post-disposal (where applicable) soil conditions shall be collected as follows:

        i. for each hectare of disposal area, 2 sampling sites shall be selected;

        ii. each sampling site shall be a circular area with a 10 metre radius, with the centre precisely located and documented;

        iii. a minimum of one composite sample for a 0-10 cm soil profile and for a 10-30 cm soil profile shall be obtained from each sampling site; and

        iv. each composite sample shall be comprised of 10 subsamples.

    b) For landspraying and landspraying-while-drilling, samples to assess pre- and post-disposal (where applicable) soil conditions shall be collected as follows:

i. for every 4 hectares of a disposal area, 1 sampling site shall be selected (minimum 2 sampling sites);

ii. each sampling site shall be a circular area with a 10 metre radius, with the centre precisely located and documented;

iii. a minimum of one composite sample for a 0-10 cm soil profile shall be obtained from each sampling site; and

iv. each composite sample shall be comprised of 10 subsamples.

c) For landspreading, samples to assess pre- and post-disposal (where applicable) soil conditions shall be collected as follows:

i. for disposal areas that are 3000 m^2 or less, a minimum of one composite sample, comprised of 5 subsamples, shall be obtained;

ii. for disposal areas that exceed 3000 m^2, the area shall be divided into equal plots that are no more than 3000 m^2 in size and one composite sample, comprised of 5 subsamples, shall be obtained for each plot;

iii. each subsample shall be collected from the 0-30 cm soil profile, or the drilling waste incorporation depth, whichever is less; and

iv. the soil:waste mix sample must not be diluted with soil from below the mixing depth.

d) For mix-bury-cover disposals, samples to assess pre- and post-disposal (where applicable) soil conditions shall be collected as follows:

i. for disposal areas that are 3000 m^2 or less, a minimum of one composite sample, comprised of 5 subsamples, shall be obtained;

ii. for disposal areas that exceed 3000 m^2, the area shall be divided into equal plots that are no more than 3000 m^2 in size and one composite sample, comprised of 5 subsamples, shall be obtained for each plot;

iii. each subsample shall be collected at the soil profile depth for incorporation of the drilling waste (excluding clean fill/cap); and

iv. the soil:waste mix sample must not be diluted with soil from above or below the mixing depth.

2. All samples shall be submitted to an accredited laboratory for analysis. Each composite sample shall be analyzed, as a minimum, for density,

texture, pH, EC, and SAR. The results shall be compared to Tables 1, 2 and 3 to verify that the selected receiving soil is eligible for drilling waste disposal and then used to predict the ability for the resulting soil:waste mix to not exceed the soil endpoints. Post disposal samples may require more extensive analyses, and should be taken from the same locations as the pre-disposal samples and must be collected within 30 days of the disposal.

For landspray-while-drilling operations, field analysis of salinity is acceptable in order to proceed with disposal. When field analyses are performed, at least one of the samples shall be split with one part of the sample being analyzed in the field for pH, electrical conductivity, sodium, SAR, and specific gravity using approved field testing methods; and the other part being submitted to an accredited laboratory for detailed salinity analysis including pH, electrical conductivity, sodium, SAR, and specific gravity. Further investigation may be required if a difference is noted between the field and laboratory results that could indicate potential for a negative environmental impact.

3. Each sampling site shall be representative of the landscape in the proposed disposal area and of the most sensitive part of the landscape (e.g., convergent footslopes and toeslopes are usually the most sensitive parts of the landscapes and may have naturally higher levels of sodium and sulphate or may have concentrated parameters from previous drilling waste disposals).

4. The sampling site shall be representative of any previous drilling waste disposals that occurred within the disposal area.

3.3 Receiving Soil Assessment

The analysis from these samples shall be used to assess background soil conditions according to the following criteria to determine whether a site is suitable to receive drilling wastes, and if so, to determine an acceptable soil:waste mix ratio or waste application rate:

1. The background soil electrical conductivity (EC) and sodium adsorption ratio (SAR) values are less than the maximum soil EC and maximum soil SAR values at the appropriate depth within the soil profile as specified in Table 1 or Table 2 (whichever is applicable to the site).

2. Within the Agricultural Land Reserve (ALR) only topsoils within the good soil rating category are eligible to be used for landspray, landspray-while-drilling, and pump-off disposal methods (see Table 3)

3. The landspreading disposal method shall only be conducted in subsoils that are within the good or fair salt rating category (see Table 3).

4. The mix-bury-cover disposal method shall only be conducted in subsoils that are deeper than 1 metre. Only subsoils within the good and fair soil rating category are eligible for mix-bury-cover disposals occurring at a depth profile between 1 and 1.5 metres, while those occurring at a profile deeper than 1.5 metres are not restricted to subsoils within specific soil rating categories. (see Table 3)

5. The difference between post-disposal soil:waste mix and background EC and SAR values shall not exceed the EC and SAR changes from background values that are set out in Table 1 or Table 2 (whichever is applicable).

6. The post-disposal soil:waste mix shall not exceed the maximum EC and maximum SAR soil values that are set out in Table 1 or Table 2 (whichever is applicable).

7. In the following circumstances, predictive laboratory assessment of soil:waste mixtures shall be completed prior to disposal to determine an appropriate soil:waste ratio or waste application rate to meet all criteria detailed in this Chapter:

    a) Pump-off - if the EC of the drilling waste is greater than 5.0 dS/m or the sodium loading rate exceeds 150 kg/ha;

    b) Landspray - if the EC of the drilling waste is greater than 10.0 dS/m or the sodium loading rate exceeds 150 kg/ha;

    c) Landspreading - if the EC of the drilling waste is greater than 8.0 dS/m or its sodium concentration is greater than 2,000 mg/L;

    d) Mix-bury-cover - if the EC of the drilling waste is greater than 10.0 dS/m or its sodium concentration is greater than 3,000 mg/L.

    Note: In circumstances where salinity parameters are lower than these values, the Operator may choose to perform laboratory analysis of predictive mixes or may use the salinity calculations provided in this document (see salinity management calculations, section 6.0).

8. For the circumstances detailed in subsection 7 (a) through (d) above and for all disposals within the ALR where salinity has been predicted using the equations in this Chapter, post disposal confirmation sampling and analysis of the soil:waste mix shall be completed to verify that the endpoints set out in Table 1 or Table 2 have not been exceeded.

9. If confirmation sampling indicates that the endpoints may have been exceeded, the Operator shall perform any further testing or remedial actions deemed necessary by the OGC until such time that the OGC is satisfied that:

    a) the site meets criteria and/or the intent of this Chapter;

b) the disposal has not resulted in a negative impact to agricultural productivity; and

c) the site poses no danger to the environment.

4.0 General Disposal Requirements

4.1 Cement Returns

Fluids associated with isolated cement returns that will not set up (harden) may be managed by the mix-bury-cover method of disposal provided that all requirements for this disposal type detailed in this Chapter are met, including:

1. sampling and disposal requirements;
2. drilling waste containment; and
3. sump construction requirements.

Cement pits shall be designed so that once covered with clean fill, the cement will not be an obstruction to further development and will not impede site drainage. Isolated cement returns that have hardened may be:

1. buried on site at a depth greater than 1.5 metres below the ground surface;
2. disposed of at an approved landfill; or
3. disposed of by other acceptable means as specified in writing by an authorized commission employee.

4.2 Disposal Methods for Non-Aqueous Mud Systems (Oil-based, Synthetic-based) and Hydrocarbon Contaminated Drill Cuttings

Where drill cuttings from a hydrocarbon based drilling operation do not contain oil, or any other constituent in an amount or concentration that would result in designation of the waste as “hazardous waste” as defined in the HWR, discharge on to land may be allowed in accordance with Sec. 7(2)(b) of the OGWR, “Requirements for discharges from specific operations”.

If, because of oil or any other constituent of the waste, the waste is designated as a hazardous waste, the waste must be handled pursuant to the requirements of the Hazardous Waste Regulation (HWR).

Prior to disposal, hazardous wastes must be treated at an approved treatment facility. The treated waste cannot be discharged from the facility until the owner of the facility can demonstrate to the satisfaction of a Director pursuant to Section 19(2)(b) of the HWR, that the residue no longer poses a hazard to human health or to the environment.

Note: Management of hazardous wastes pursuant to the Hazardous Waste Regulation is entirely the jurisdiction of the Ministry of Environment and regulated under the Hazardous Waste Regulation.

4.3 Approval Procedure for a Hazardous Waste Treatment Facility

To operate a hazardous waste treatment facility, the Operator must own, lease, or have tenure over the site. The Operator must have the plans for the facility approved pursuant to Section 4 of the HWR. This involves the preparation of a report with construction and operational plans and submission to the Director, Ministry of Environment for approval. The report shall be prepared by a qualified professional and shall state that all the requirements of the HWR have been complied with. The report shall include, but is not limited to:

1. site location;
2. plans and specification of works;
3. the type and volume of the waste to be treated;
4. a monitoring and reporting program; and
5. a closure plan.

This section is intended for guidance purposes only. For detailed information regarding the procedures and operational requirements of operating a treatment facility under the HWR, contact:

Ministry of Environment
Room 400, 10003 - 110th Avenue
Fort St. John, BC
V1J 6M7

Ph: (250) 787-3411
Fx: (250) 787-3490

4.4 Other Disposal Methods

It is the responsibility of the Operator to ensure that the method of disposal is approved for the type of mud system used. If an alternate disposal method not endorsed in this Chapter is being considered, the Operator requires written authorization from the Manager prior to conducting any waste disposal.

4.5 Landowner Permission to Dispose of Drilling Waste

Whenever drilling wastes are disposed of onto private land that is not part of the lease agreement for the well that generated the waste, the Operator shall obtain written consent from the landowner prior to disposal. This consent must be obtained before the Operator applies for a waste disposal reference number.

4.6 Requirement to Use the Drilling Waste Tracking System

Prior to conducting any disposal of drilling waste, drill cuttings, or cement returns, by any of the methods approved in this Chapter, the Operator shall access the OGC drilling waste tracking system and obtain a reference number for the drilling waste disposal. The Operator shall accurately enter all information required by this system including the E-PASS submission of shape files to accurately depict all disposal areas. All information submitted to this system may be subject to audit by the OGC.

If there is a technical problem with the drilling waste tracking system that prevents the Operator from recording this information prior to disposal of drilling waste, the Operator may carry out the disposal activity if:

1. it meets all other applicable requirements in this Chapter;
2. prior to disposal, the Operator faxes a notice of intent to dispose of drilling waste to the attention of the Manager at (250) 261-2050; and
3. the above data is entered into the drilling waste tracking system within fourteen days after the technical problem has been fixed.

Note: This drilling waste tracking system is only for those wastes that are not classified as hazardous waste under the HWR. Hazardous waste shall continue to be registered, manifested and tracked as described in the HWR.

Within 30 days of conducting a drilling waste disposal or within 30 days of the completion of any required post disposal confirmation sampling, a Drilling Waste Disposal Summary form along with related attachments shall be submitted to the Manager by email at OGCWaste.Management@gov.bc.ca. The email subject line should be labeled according to the following convention, where (#) is the disposal number generated by the Drilling Waste Tracking System:

Subject: DWDS (#)

4.7 Accessing the Drilling Waste Tracking System

The drilling waste tracking system may be accessed via the OGC website https://quoll.ogc.gov.bc.ca/generic_ogc/Ext_Accnt.Logon where a user name and profile must be completed. Once a user profile has been established, the Waste Management Section of the OGC must be contacted to establish the user's system privileges. Contact the Operations Engineering Branch Administrator by phone: (250) 261-5700 or email: OGCWaste.Management@gov.bc.ca.

An Operator may choose to have more than one person authorized to access this system. An Operator may also choose to use a third party who is not a direct employee of the Operator to enter information into this system. In such cases the Operator shall provide the OGC with a letter of consent naming any individual who the company wishes to be authorized to access the system on their behalf.

Operators should understand that any individual that is authorized to access the system on their behalf will have access to all of the Operator's drilling waste disposal records retained within the system.

There is an online user's guide that can be accessed once a user has logged in to the system. Questions regarding use of the drilling waste tracking system should be directed to the Operations Engineering Branch Administrator by phone: (250) 261-5700 or email: OGCWaste.Management@gov.bc.ca.

4.8 Sampling Procedures

Collection, preservation and storage of samples are critical to the results of testing. All samples shall be collected and handled in accordance with the requirements of the British Columbia Environmental Laboratory Manual http://www.env.gov.bc.ca/air/wamr/labsys/lab_man_05.html and the requirements of the accredited laboratory that conducts the chemical analysis.

In principle, samples shall be free of secondary contamination and, when analyzed in the laboratory, provide results which are representative of the source or problem under investigation. Collect a representative sample of each of the fluid and solid phases of the waste from each discrete sump at a given location. Representative samples from each discrete sump are required because wastes may be the result of unique mud systems which may be disposed of by different techniques.

Sumps should be sampled as close as possible to the date of drilling waste disposal. If the disposal has not occurred within 6 months of the original sampling date, the sump shall be re-sampled and analyzed for the appropriate parameters at an accredited laboratory prior to disposal. Immediately prior to any drilling waste disposal from a sump, the sump shall be inspected for evidence of any onsite activity or dumping of waste that may have occurred since the sump was sampled. If disposal occurs more than 30 days after the sump was sampled, analysis shall be conducted using accepted field methods for pH and EC to ensure that these parameters are consistent with the laboratory data. If there is any evidence from the inspection or analysis indicating that material may have been added to the sump since the date of sampling, the sump shall be sampled again to ensure that the waste meets all requirements of this Chapter prior to disposal. A sketch showing all sampling locations and depths shall be submitted to the OGC as part of the Drilling Waste Disposal Summary form.

4.8.1 Sample Collection

The minimum distance at which samples shall be obtained from the edge of a sump is one meter.

For sumps with a surface area less than or equal to 500 m^2, collect samples from at least five locations. For sumps with a surface area greater than 500 m^2,

sample one location for each 100 m^2 of surface area to a maximum of 10 locations. Collect a sample from the entire depth of each of the fluid and solid phases of the waste material at each location. The suction and discharge points represent two fixed sampling locations and shall be sampled if they are identifiable.

To sample the Fluid, Clear Liquids or Solids phase of a sump:

1. Collect individual sub-samples according to the planned disposal procedure. Include any hydrocarbon layer in the sample if the hydrocarbon will not be removed prior to disposal.
2. Prepare a composite sample with equal amounts of five sub-samples.
3. Portions of the composite sample shall be sub-sampled into containers as appropriate for the analysis to be completed.

If the fluid and solid phases of the sump are to be disposed of together, a Total Waste sample must be taken. A Total Waste sample is a sample that is taken from the whole depth of the fluids and solids at one time and must not be made up of individually sampled fluid and solid phases. To sample the Total Waste phase of a sump:

1. Collect individual sub-samples according to the planned disposal procedure.
2. Prepare a composite sample with equal amounts of five sub-samples.
3. Portions of the composite sample shall be sub-sampled into containers as appropriate for the analysis to be completed.

4.9 Analytical Methods

All laboratory analyses of discharges pursuant to the OGWR are to be carried out in accordance with procedures described in the latest version of the British Columbia Environmental Laboratory Manual
http://www.env.gov.bc.ca/air/wamr/labsys/lab_man_05.html
or by suitable alternative procedures authorized by the Manager or a Director.

Information on analytical methods to assess certain substances referred to in the CSR may be found on the MoE contaminated sites web site.
http://www.env.gov.bc.ca/epd/epdpa/contam_sites/index.html
All analyses required for drilling waste disposal should reference analytical procedures and be conducted by an accredited laboratory.

Approved field testing methods include the use of pH meters and Ion Selective Electrode technology, providing that the equipment is calibrated according to manufacturers specifications and that the methodology is supported by an ongoing QA/QC program. **The use of pH strips for pH measurement is not an approved field test method.**

4.10 Toxicity Assessment

A bioassay based toxicity assessment is used as a screen for the presence of components toxic to life forms which may not be detected by routine chemical analyses, but may be present in the drilling waste. When toxic effects are identified, the source of the effects must be identified and managed as part of the overall disposal plan.

An evaluation of the potential toxicity is required for both the fluids and solids or total waste components for all drilling wastes. By examining the mud products used and the operations at the well site, the Operator may determine that toxicity testing is not required.

All analyses for testing the toxicity of discharges pursuant to the OGWReg are to be carried out in accordance with procedures described in the latest version of British Columbia Environmental Laboratory Manual http://www.env.gov.bc.ca/air/wamr/labsys/lab_man_05.html, or by suitable alternative procedures authorized by the Manager or a Director.

4.10.1 Potential Toxicants

Nine groups of drilling mud additives have been identified as potential toxicants:

1. bactericides;
2. corrosion inhibitors;
3. defoamers;
4. emulsifiers / de-emulsifiers;
5. foaming agents;
6. lubricants;
7. polymer stabilizers and breakers;
8. shale control inhibitors; and
9. surfactants.

Not all products in the above groups exhibit toxic effects. The Petroleum Services Association of Canada (PSAC) maintains the “Drilling Fluid Product Toxicity Listing for Potential Toxicity Information” http://www.psac.ca/mudlist/. This listing contains toxicity assessment data for mud products in these groups at the concentrations which they are normally used. Product suppliers may also maintain equivalent toxicological data for their products.

4.10.2 Requirement to Complete a Bioassay

A Microtox® bioassay is required when:

1. a hydrocarbon flag was encountered;
2. an additive from a potential toxicant group was used in the drilling mud in a concentration which exceeds known toxicity thresholds; or
3. an additive for which toxicity information does not exist was used in the drilling mud.

An additive is considered to have exceeded known toxicity thresholds when it is used in a concentration which exceeds the concentration for which the original Microtox® bioassay results shows the product to have an EC50(15) equal to or greater than 75%.

Alternative bioassay methods may be authorized by the Manager or a Director.

4.10.3 Microtox® Bioassay Criteria

1. If the EC50(15) value of the Microtox® bioassay is equal to or greater than 75%, the drilling waste is considered to be non-toxic and is suitable for subject to the requirements of the selected disposal method.

2. If the EC50(15) value of the original Microtox® bioassay is less than 75%, a second bioassay must be run following charcoal treatment of the sample in the lab.

3. Samples with an original Microtox® EC(15) less than 75% and a charcoal treatment Microtox® greater than or equal to 75% must be tested for hydrocarbon content. Disposal may proceed if hydrocarbon analysis indicates that hydrocarbons are present and are the likely source of toxicity, provided that the disposal meets the relevant hydrocarbon criteria for the disposal method as detailed in this Chapter.

4. Samples with an original Microtox® EC50(15) less than 75% and a charcoal treatment Microtox® less than 75% are indicative of the presence of toxicants. Further data must be gathered to determine the cause of toxicity prior to disposal.

4.10.4 Failure to Meet Bioassay Criteria

Failure to meet the bioassay criteria may be due to the presence of toxicants listed in section 4.10.1 of this Chapter. Mud usage listings should be examined to determine if any potential toxicants were added to the mud or present in any mud additives. Operating practices should also be reviewed to determine if any potentially toxic materials may have been introduced due to operations.

Additional laboratory testing may be required to determine if field treatment methods will reduce toxicity. This may include an alternative bioassay, aeration, pH adjustment, charcoal addition, flocculation, centrifugation, filtration, chemical precipitation and chemical oxidation. Subsequent to any in-field treatment, the waste must be analyzed to confirm that the treated waste meets the toxicity requirements.

If the toxicity of the waste cannot be reduced to satisfactory levels, the drilling waste must be disposed at a licensed waste disposal facility or as authorized by the Manager.

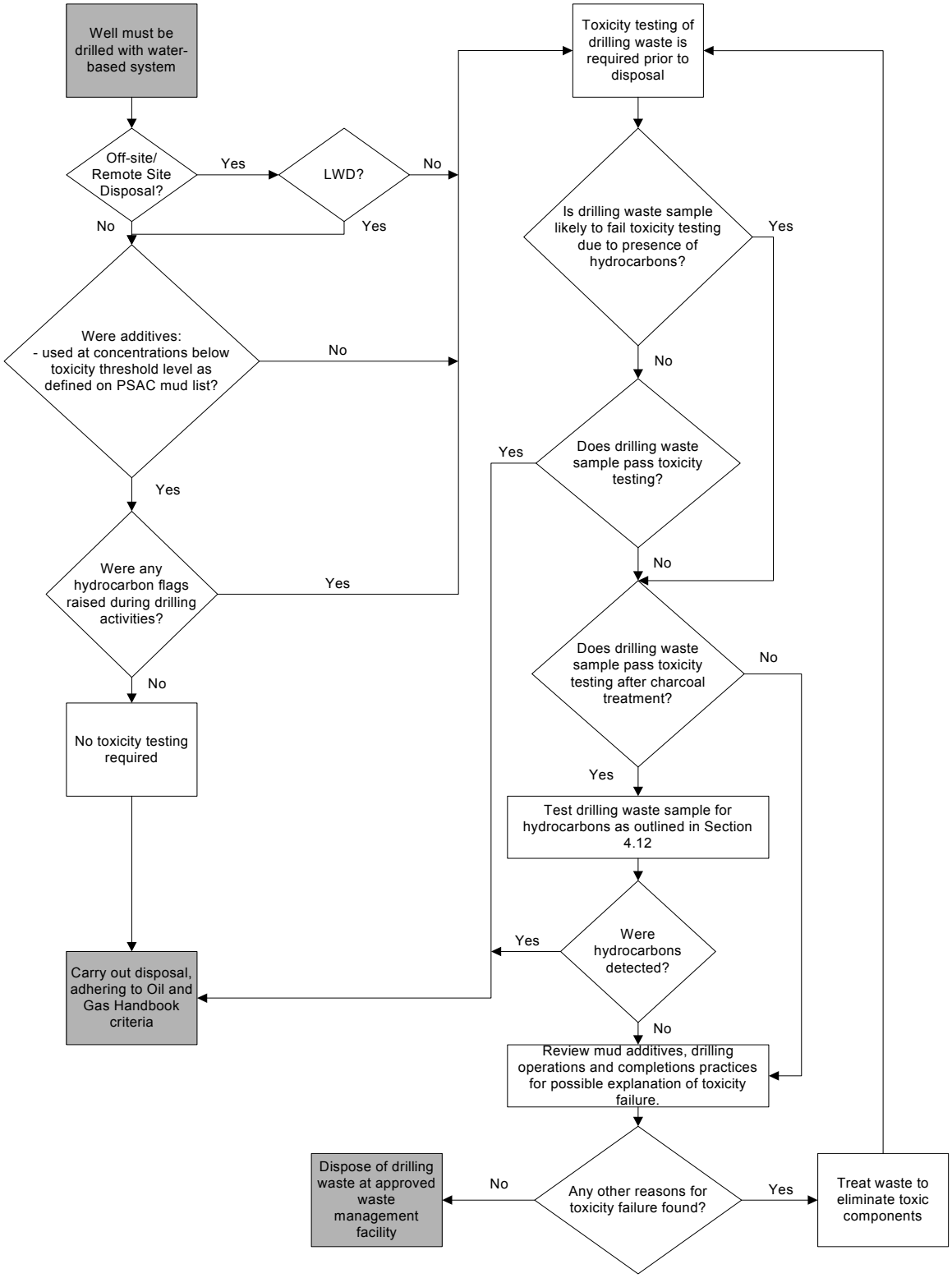

Figure 1. Toxicity Assessment Flow Chart

4.11 Loading Criteria

The final concentration of substances in the soil:waste mixture must comply with all relevant standards as set out in the *Contaminated Sites Regulation* (CSR).

Note: At the time of release of this update to the Oil and Gas Handbook, sodium and chloride ions are scheduled substances under the CSR that have no defined standard. Operators shall be aware that high-salt mud systems, or high concentrations of certain additives in mud systems may result in soil:waste mixtures that could exceed future CSR standards.

The salinity criteria detailed in this Chapter have been established to be protective of surface soils and vegetation, and to prevent drilling waste disposal activities from resulting in significant impacts to site productivity or to the environment.

4.12 Petroleum Hydrocarbons

The application of drilling waste to land following any disposal method shall not result in hydrocarbon concentrations at the disposal area exceeding the CSR standards for the designated land use. The Operator shall perform hydrocarbon analysis as required to ensure that CSR standards are not exceeded. The Operator shall ensure that all drilling waste applications conform to CSR standards.

In this Chapter the term “hydrocarbon flag” means any situation that might indicate that hydrocarbon has been introduced into a water-based drilling waste. Examples include:

1. the well is a horizontal oil well;
2. a diesel pill was added;
3. any other hydrocarbon was added through any drilling practice such as underbalanced drilling or drill stem testing;
4. a well kick or blowout has occurred that could return hydrocarbons to surface;
5. there are visible hydrocarbons in the drilling waste (detected by the observance of a rainbow sheen); or
6. there was a toxicity assessment failure.

When a hydrocarbon flag occurs, drilling waste shall be analyzed to determine the concentrations of hydrocarbons in the waste. Standard hydrocarbon analyses include:

1. VPH – volatile petroleum hydrocarbons;
2. BTEX – benzene, toluene, ethylbenzene and xylene
3. LEPH – light extractable petroleum hydrocarbons;

4. HEPH – heavy extractable petroleum hydrocarbons; and
5. PAH – polycyclic aromatic hydrocarbons.

The Operator is responsible to perform hydrocarbon analyses that would include the full range of any potential hydrocarbons that are likely to be present in the waste. The following examples illustrate this point:

1. If a diesel pill were added to the drilling mud, the waste would need to be analyzed for LEPH, HEPH, PAH and BTEX compounds.
2. If an accumulation of formation fluids as a result of underbalanced drilling of a gas well is confirmed to be the only source of hydrocarbon, then the waste would require VPH and BTEX analysis; whereas the same situation drilling though oil bearing formations would require VPH, BTEX, LEPH, HEPH and PAH analysis.

4.13 Metals

The Operator shall ensure that the final concentrations of metals in the soil:waste mixture comply with the relevant CSR standards at the disposal site.

4.14 Treatment of Wastes

If any treatment of waste is performed to help the waste meet the disposal criteria of this Chapter (except for a pH adjustment performed in accordance with section 5.2.2 subsection 6 of this Chapter), then the waste shall be sampled and analyzed after the treatment has occurred to ensure that the waste meets the criteria for the selected disposal method prior to disposal.

5.0 Disposal Methods for Water-based Mud Systems

The following disposal methods for water-based mud systems are acceptable. During any disposal operation, a copy of the required analyses shall be available onsite and made available at that time if requested by an OGC or MoE employee. Waste that is classified as hazardous waste under the *Hazardous Waste Regulation* shall not be disposed of by the methods described in this Chapter.

5.1 On-Site Disposal Options

5.1.1 Mix-Bury-Cover Disposal Method

The mix-bury-cover (MBC) disposal method involves mixing drilling waste solids (and sometimes fluids or the total waste) with subsoils, at a depth below either 1 metre or 1.5 metres, to form a stabilized soil:waste mass below the main rooting zone.

Typical mix-bury-cover methods are:

1. Mix waste and subsoil in the sump and cover.
2. Mix waste from the sump and subsoil on the surface, then put the mixture back in the sump and cover.
3. Bail the waste from the sump onto the lease surface, mix with the subsoil, and bury when filling in a cut.
4. Spread the wastes on the lease surface, and allow them to dry. Put the wastes back into the sump, then mix and cover.

Note: In cases where the waste is allowed to dry prior to mixing, the mix ratio must be based on the volume of waste at the time of sampling, not after the waste has dried.

5.1.2 Mix-Bury-Cover Requirements

1. A sample of the drilling waste must be taken, either:
    a) a total waste (fluids and solids) sample, if both phases are being managed by mix-bury-cover, or
    b) a solids sample, if only the solid phase is being managed by mix-bury-cover.

2. The sample must be analyzed for the parameters listed below and the results used to determine a soil:waste mix ratio that will prevent the receiving soil from exceeding the criteria in this Chapter and the CSR standards.
    a) EC;
    b) [Na];

c) SAR;

d) metals - if metals listed in schedules 4, 5 or 10 of the CSR were added to the drilling mud system;

e) hydrocarbons as described in section 4.12 “Petroleum Hydrocarbons”, if a hydrocarbon flag was encountered; and

f) toxicity - if required according to section 4.10 “Toxicity Assessment”, or if a hydrocarbon flag was encountered.

3. If a hydrocarbon flag is encountered, or if the initial toxicity assessment fails, but passes after being charcoal treated, disposal may proceed if VPH, BTEX, LEPH, HEPH and PAH do not exceed the relevant CSR standards for the designated land use in the soil:waste mix.

4. The Operator shall ensure that the waste application rate shall comply with the requirements of Sections 5.3 and 6.2 of this Chapter.

Note: If predictive laboratory or calculated mix ratios exceed 7 parts soil to one part waste for a mix-bury-cover disposal, it is recommended that the Operator either treat the waste, re-test the waste to verify suitability of the method or choose a more appropriate disposal method. If the Operator chooses to proceed with mix-bury-cover disposal, post disposal sampling is required with no less than 6 discrete samples taken from locations evenly spaced throughout the disposal area that are representative of the soil waste mixture at each discrete location.

5. The disposal of drilling waste resulting in more than 400 kg nitrogen /ha must be restricted to subsoils of limited permeability, which have a fines content of at least 40% and a clay content of at least 28%.

6. The soil:waste mixture must be covered by a minimum of 1 metre, or 1.5 metres of clean fill (see Tables 1 and 2). The EC and SAR of the clean fill must meet the salt category rating of the original onsite soil (at the appropriate depth within the soil profile) prior to disturbance (see Table 3).

Note: Operators are cautioned that the use of naturally saline subsoils as fill material may introduce levels of salts within the rooting zone that exceed this requirement, and may interfere with the reclamation objective to restore the site to equivalent land capability.

7. The drilling waste disposal area shall not overlap any area that has previously been used for mix-bury-cover disposal.

8. Post disposal confirmation sampling and analysis of the soil:waste mix must be conducted and the results compared to the applicable soil quality objectives if:

a) the EC of the drilling waste exceeds 10 dS/m; or

b) the sodium content of the drilling waste exceeds 3,000 mg/L.

9. Where post disposal sampling is required, a report of analytical results must be submitted to the Manager no later than 90 days after the disposal event occurred.

5.1.3 Landspreading Disposal Method

The landspreading method involves spreading water based drilling waste on the shallow subsoil of land and incorporating the waste into the shallow subsoil.

Landspreading disposal is defined as a one-time application on the wellsite or remote sump site to the subsoil. It is not intended to be a treatment or aerating method whereby the drilling waste is subject to continuous discing or mixing in order to meet applicable criteria.

Typical methods for landspreading are:

1. Rip the subsoil, spread and incorporate the drilling waste on-site.
2. Spread (squeeze) the drilling waste on-site, dry and incorporate the waste into the subsoil.

Note: In cases where the waste is allowed to dry prior to incorporation, the mix ratio must be based on the volume of waste at the time of sampling, not after the waste has dried.

5.1.4 Landspreading Requirements

1. A sample of the drilling waste must be taken, either as:
    a) a total waste (fluids and solids) sample, if both phases are being managed by landspreading; or
    b) a solids sample, if only the solid phase is being managed by landspreading .

2. The sample must be analyzed for the parameters listed below and the results used to determine the soil:waste mix ratio that will prevent the receiving soil from exceeding the criteria in this Chapter and the CSR standards.
    a) EC;
    b) [Na];
    c) SAR;
    d) metals - if metals listed in schedules 4, 5 or 10 of the CSR were added to the drilling mud system;
    e) hydrocarbons as described in section 4.12 “Petroleum Hydrocarbons”, if a hydrocarbon flag was encountered; and

f) toxicity - if required according to section 4.10 “Toxicity Assessment”, or if a hydrocarbon flag was encountered.

3. If a hydrocarbon flag is encountered, or if the initial toxicity assessment fails, but passes after being charcoal treated, disposal may proceed if VPH, BTEX, LEPH, HEPH and PAH do not exceed the relevant CSR standards for the designated land use in the soil:waste mix.

4. The Operator shall ensure that the waste application rate shall comply with the requirements of Sections 5.3 and 6.1 of this Chapter.

   Note: If predictive laboratory or calculated mix ratios exceed 7 parts soil to one part waste for a mix-bury-cover disposal, it is recommended that the Operator either treat the waste, re-test the waste to verify suitability of the method or choose a more appropriate disposal method. If the Operator chooses to proceed with mix-bury-cover disposal, post disposal sampling is required with no less than 6 discrete samples taken from locations evenly spaced throughout the disposal area that are representative of the soil waste mixture at each discrete location.

5. Waste shall be uniformly applied and the application rate shall not exceed 1,000 m^3 per hectare (10cm thickness) across the disposal area.

6. The disposal of drilling waste resulting in more than 400 kg nitrogen /ha must be restricted to subsoils of limited permeability, which have a fines content of at least 40% and a clay content of at least 28%.

5.2 Off-Site Disposal Options

5.2.1 Liquids Disposal by Pump-Off Disposal Method

The pump-off disposal method involves the controlled application of clear-liquid, drilling wastes onto land that is usually vegetated, following calculated loading criteria. The clear liquids must meet the disposal criteria without being incorporated into the topsoil.

This method typically involves pumping clear-liquid drilling wastes through hoses or irrigation equipment such as a big gun, sprinkler, gated pipe, or perforated hose. Vacuum trucks and water trucks may also be used to perform a controlled application of clear-liquid drilling waste by this method.

Disposal of clear-liquid drilling fluids by the pump-off method is intended for one time application to a given disposal site. If the pump-off disposal area overlaps any area that has previously been used for pump-off disposal, the Operator shall ensure that any increase in EC or SAR at the site complies with the criteria in Table 1 or 2 (as appropriate) and that any predicted change in EC and SAR is measured from true background conditions. The Operator shall notify the Manager in writing prior to commencing the disposal if the disposal area overlaps

any area that has previously been used for pump-off disposal, and must perform post disposal confirmation sampling of the disposal area.

5.2.2 Pump-Off Disposal Requirements

1. The pump-off disposal method is limited to the portion of drilling wastes that qualify as clear liquids (i.e., fluid that appears non-turbid when sampled from the discharge point and may be colourless or may have natural colour or staining).

2. The clear liquids must be sampled and analyzed for the parameters listed below and the results used to determine the soil/waste mix ratio that will prevent the receiving soil from exceeding the criteria in this Chapter and the CSR standards:
    a) EC;
    b) [Na];
    c) SAR;
    d) metals - if metals listed in schedules 4, 5 or 10 of the CSR were added to the drilling mud system;
    e) hydrocarbons as described in section 4.12 “Petroleum Hydrocarbons”, if a hydrocarbon flag was encountered; and
    f) toxicity - if required according to section 4.10 “Toxicity Assessment”, or if a hydrocarbon flag was encountered.

3. The fluid must not contain any visible hydrocarbons (defined as the observance of a rainbow sheen).

4. The Operator shall ensure that the waste application rate shall comply with the requirements of Sections 5.3 and 6.2 of this Chapter.

5. If a hydrocarbon flag is encountered, or if the initial toxicity assessment fails, but passes after being charcoal treated, the waste must be analyzed for VPH, BTEX, LEPH, HEPH and PAH. Spread rates must be determined to ensure that VPH, PAH and BTEX concentrations will not exceed CSR standards for the applicable land use and that the sum of LEPH and HEPH does not exceed 100 mg/L.

6. The fluid must have a pH that is between 5.5 and 8.5. If the pH falls outside of these values, the fluid may be treated to adjust pH, provided that accepted field testing methods are used to verify the pH and EC prior to pump off. If field testing results indicate a post adjustment EC of 5 dS/m or greater, the adjusted fluids must be submitted for lab analysis to verify that the salinity criteria of this Chapter will be met. If the post adjustment EC is less than 5 dS/m, the disposal may proceed provided

that the spread rate calculations have been determined using the highest EC value from either laboratory or field analysis to ensure that the salinity criteria in this Chapter will be met.

7. The EC of the fluid must not exceed 10 dS/m.

8. Pump-off disposals of drilling wastes shall be conducted so that:
    a) the liquid is discharged at a rate at which there is no accumulation of effluent on the surface of the ground;
    b) the discharge does not cause erosion or result in measurable downward and outward movement of soil, rocks, snow, ice, mud or debris;
    c) the discharge is on to a stable slope; and
    d) the liquid is not allowed to enter a surface watercourse or surface water body and is not discharged in a location where it could reasonably be expected to enter a surface watercourse or surface water body.

9. Post disposal sampling of the soil:waste mix must be conducted if the EC of the clear liquids exceeds 5.0 dS/m or if the sodium loading rate exceeds 150 kg/ha.

10. No portion of the disposal area shall be within 100 metres of a domestic or agricultural water source or water well.

5.2.3 Landspraying Disposal Method

The landspray disposal method involves spraying liquid or slurried total waste on to topsoil and may or may not involve incorporation. Incorporation typically occurs when the drilling waste has been landsprayed on cultivated land and is accomplished by mechanically combining the drilling waste into a homogeneous soil:waste mix. Drilling waste that has been landsprayed on vegetated land is typically not incorporated. A calculated loading rate or maximum application rate is used to determine the area required for landspraying.

Landspraying operations may occur on lands owned or leased by the Operator and may also occur on crown owned winter access roads or pipeline right of ways, provided these locations have been approved by the OGC (see the “Disposal on Leases, Access and Pipelines” section of this Chapter).

5.2.4 General Landspraying Requirements

1. Separated solids and cuttings must be managed by a different method (i.e., mix-bury-cover, landspreading,) or alternatively, be sent to an approved waste management facility.

2. The drilling waste must:
    a) be contained prior to landspraying;
    b) if only the fluids are to be landsprayed and the solids are to be managed by another option, a fluids sample must be obtained; or
    c) if fluid and solid phases are to be landsprayed together in a slurry, a total waste sample must be obtained; and
    d) the drilling waste sample must be analyzed for the parameters listed below and the results used to ensure that spread rates meet all the applicable criteria:
        i. pH;
        ii. EC;
        iii. specific gravity;
        iv. SAR;
        v. soluble nitrogen;
        vi. metals - if metals listed in schedules 4, 5 or 10 of the CSR were added to the drilling mud system;
        vii. hydrocarbons as described in section 4.12 “Petroleum Hydrocarbons”, if a hydrocarbon flag was encountered; and
        viii. toxicity - if required according to section 4.10 “Toxicity Assessment”, or if a hydrocarbon flag was encountered.

3. The Operator shall ensure that everyone involved in landspraying operations understands how to perform their duties in accordance with this Chapter and the disposal shall be conducted under the supervision of a person who knows and understands the drilling waste disposal requirements of this Chapter.

4. Landspray disposal of drilling wastes shall be conducted so that:
    a) the drilling waste is discharged at a rate at which there is no accumulation of effluent on the surface of the ground;
    b) the discharge does not cause erosion or result in measurable downward and outward movement of soil, rocks, snow, ice, mud or debris;

c) the discharge is on to a stable slope;

d) the fluid is not allowed to enter a surface watercourse or surface water body and is not discharged in a location where it could reasonably be expected to enter a surface watercourse or surface water body; and

e) the discharge does not occur on areas of muskeg where surface organic matter is greater than 30cm deep or where indicators of near surface water such as stunted black spruce and sphagnum moss are present.

5. The Operator shall ensure that the waste application rate shall comply with the requirements of Sections 5.3 and 6.2 of this Chapter.

6. Summer operations (non-frozen ground) are limited to a maximum landspray rate of 40 m^3/ha, uniformly applied over the application area.

7. Winter operations on land within the Agricultural Land Reserve are limited to a maximum landspray rate of 20 m^3/ha. The winter rate of 20 m^3/ha is in effect at times when the soil is saturated with water, ice-covered, snow-covered, or frozen.

8. Post disposal confirmation sampling and analysis of the soil:waste mix must be conducted if the EC of the waste exceeds 10 dS/m or if the sodium loading rate exceeds 150 kg/ha.

9. The point of access to privately owned lands that are used for landspray operations shall be clearly marked with a sign that details the name of the Operator, and the well authorization number from which the drilling waste has been generated.

10. No more than one application of drilling waste shall occur in a given location per season, per calendar year.

11. No portion of the disposal area shall be within 100 metres of a domestic or agricultural water source or water well.

12. Disposal onto the same parcel may occur in subsequent years so long as the cumulative change in salinity criteria (EC and SAR) does not exceed the allowed increase detailed in this Chapter when compared to true background conditions.

13. Compaction and access impact (rutting) must be discussed with the landowner prior to disposal to ensure expectations have been understood between both parties. Landspray operations must not measurably degrade the productive capability of the land.

5.2.5 Requirements Specific to Landspraying With Soil Incorporation

In addition to meeting the general landspraying requirements set out above, the following requirements must be followed when landspraying with soil incorporation.

1. The pH of the drilling waste shall not be less than 5.5.

2. The drilling waste must be incorporated into the receiving soil within 3 months of application, or as soon as the site can be tilled following spring thaw. Incorporation must not result in the mixing of soil horizons.

3. If a hydrocarbon flag is encountered or if the initial toxicity assessment fails, but passes after being charcoal treated, the waste must be analyzed for VPH, BTEX, LEPH, HEPH and PAH. Spread rates must be determined to ensure that concentrations of these parameters will not exceed CSR standards for the applicable land use and waste must be incorporated into the receiving soil within 2 weeks of the disposal.

5.2.6 Requirements Specific to Landspraying Without Soil Incorporation

In addition to meeting the general landspraying requirements set out above, the following requirements must be followed when landspraying without soil incorporation.

1. The pH of the drilling waste shall not be less than 5.5 or greater than 10.5.

2. The application rate of drilling waste solids shall not exceed 6 evenly distributed tonnes per hectare.

3. If a hydrocarbon flag is encountered or if the initial toxicity assessment fails, but passes after being charcoal treated, the waste must be analyzed for VPH, BTEX, LEPH, HEPH and PAH. Spread rates must be determined to ensure that VPH, BTEX and PAH concentrations will not exceed CSR standards for the applicable land use and the sum of LEPH and HEPH must not exceed 1000 mg/L in the fluids or 1000 mg/kg in the total waste, as applicable.

4. Drilling waste shall not be applied to a parcel of vegetated land if any trace of a previous disposal is evident. This is to ensure sufficient time for a previous disposal to dissipate into the soil structure and to prevent vegetation stress (i.e., coated with drilling waste). No more than one application of drilling waste shall occur on a given site in the same calendar year.

5.2.7 Landspraying While Drilling (LWD) Disposal Method

The landspray while drilling (LWD) disposal method involves spraying non-toxic drilling wastes onto topsoil at controlled, low application rates. Although incorporation is at the discretion of the landowner, the intent of this disposal method is such that the drilling waste meets all applicable endpoints without the need for incorporation. Should incorporation be necessary to meet all applicable criteria, then the landspray disposal option should be used. The controlled application is normally conducted during the drilling operation. Spraying techniques may include the use of vacuum trucks or similar equipment.

LWD disposal may occur on lands owned or leased by the Operator. LWD may also occur on crown owned winter access roads or pipeline right of ways, provided that these locations have been approved by the Manager (see the section titled Disposal on Leases, Access and Pipelines).

5.2.8 Landspray-While-Drilling Requirements

Changes made to the drilling mud formulation as different sections of a well are drilled (e.g., top, middle, and bottom hole) require that representative samples of the drilling waste from each section be sampled and analyzed separately, prior to commencing with LWD operations and in accordance with the following criteria:

1. The LWD disposal method is limited to freshwater gel chemical mud systems where the resulting drilling waste (fluids or total waste):
    a) has a pH greater than 5.5;
    b) has a pH lesser than 10.5 if the waste is applied to vegetated land;
    c) has an EC that does not exceed 16 dS/m;
    d) has not been exposed to a hydrocarbon flag (see section 4.12);
    e) does not contain metals listed in schedules 4, 5 or 10 of the CSR in concentrations exceeding the applicable CSR standards.
    f) does not contain any substance that requires the completion of a toxicity assessment (see section 4.10).

    Note: If changes to the drilling program present any uncertainty about the drilling waste passing toxicity assessment; or any of the salinity, hydrocarbon, or metals criteria, then the drilling waste must be managed by another method.

2. The drilling waste must be sampled and analyzed for:
    i. pH;
    ii. specific gravity;
    iii. [Na];
    iv. EC; and

v. SAR.

3. The Operator shall ensure that everyone involved in LWD operations understands how to perform their duties in accordance with this Chapter. The disposal shall be conducted under the supervision of a person who knows and understands the drilling waste disposal requirements of this Chapter.

4. LWD disposal of drilling wastes shall be conducted so that:
    a) The drilling waste is discharged at a rate at which there is no accumulation of effluent on the surface of the ground in excess of the calculated application rate;
    b) The discharge does not cause erosion or result in measurable downward and outward movement of soil, rocks, snow, ice, mud or debris;
    c) The discharge is on to a stable slope;
    d) The waste does not enter a surface watercourse or surface water body and is not discharged in a location where it could reasonably be expected to enter a surface watercourse or surface water body. A minimum setback of 100m is required from any watercourse of waterbody that is downslope of the disposal area.
    e) The discharge does not occur on areas of muskeg where surface organic matter is greater than 30cm deep or where indicators of near surface water such as stunted black spruce and sphagnum moss are present.

5. The Operator shall ensure that the waste application rate shall comply with the requirements of Sections 5.3 and 6.2 of this Chapter.

6. Summer operations (non-frozen ground) are limited to a maximum landspray rate of 40 m^3/ha, uniformly applied over the application area.

7. Winter operations on land within the agricultural land reserve are limited to a maximum landspray rate of 20 m^3/ha. The winter rate of 20 m^3/ha is in effect at times when the soil is saturated with water, ice-covered, snow-covered, or frozen.

8. If the drilling waste is sprayed on vegetated land, the application rate of drilling waste solids must not exceed 6 uniformly applied tonnes per hectare.

9. Drill stem test fluids, or sections of mud system contaminated with other hydrocarbons must be isolated and disposed of at an approved facility.

10. Any remaining drill cuttings must be managed following the requirements for mix-bury-cover or landspreading, or alternatively be sent to an approved waste management facility for disposal.

11. Disposal shall be completed within 48 hours of rig release. The Operator shall have a contingency plan to ensure adequate containment of the drilling waste is available if the disposal cannot be completed within 48 hours of rig release. This plan shall address additional testing requirements to ensure that the wastes have not been altered prior to disposal.

12. Post disposal confirmation sampling and analysis of the soil:waste mix must be conducted if the EC of the drilling waste exceeds 10 dS/m or the sodium loading rate exceeds 150 kg/ha.

13. No more than one application of drilling waste shall occur over a given disposal area per calendar year.

14. Disposal onto the same disposal area may occur in subsequent years so long as the cumulative change in salinity criteria (EC and SAR) do not exceed the allowed increased detailed in this Chapter when compared to true background conditions.

15. The point of access to privately owned lands that are used for LWD operations shall be clearly marked with a sign that details the name of the Operator, and the well authorization number from which the drilling waste has been generated.

16. No portion of the disposal area shall be within 100 metres of a domestic or agricultural water source or water well.

17. Compaction and access impact (rutting) must be discussed with the landowner prior to disposal to ensure expectations have been understood between both parties. Landspray operations must not measurably degrade the productive capability of the land.

5.2.9 Disposal on Crown Leases, Access, or Pipeline Rights of Way

The Operator shall apply to the Manager for authorization to perform landspraying while drilling operations on crown owned access, lease or pipeline rights of way. Please contact the Manager regarding applications of this type.

5.3 Salinity Criteria

The salinity criteria in this Chapter allow low-salinity wastes to be disposed of based on calculations that are intentionally conservative to account for inherent variability and still provide adequate environmental protection. For specified low-salinity wastes, the Operator may choose to use these calculations or to submit waste and receiving soil samples to an accredited laboratory to determine an appropriate soil:waste mix-ratio to meet disposal criteria. Specified higher salinity wastes must be sent to an accredited laboratory for analysis and determination of appropriate soil:waste mix-ratio.

The following criteria are being implemented to help manage salinity and sodicity to protect the quality of receiving soils, and to prevent drilling waste disposal activities from resulting in significant impacts to vegetation, site productivity, agricultural capability of land within the ALR, and the environment in general. These criteria outline the maximum increases in EC, SAR, sodium loading and nitrogen loading that are acceptable for the disposal of drilling waste. Operators shall be aware that site-specific conditions could result in the EC and SAR criteria in Tables 1 and 2 being too high to ensure protection to the environment.

Caution should be exercised when applying saline wastes to hay and pasture land where salt sensitive species are growing such as red clover, alsike clover, alfalfa, and timothy. Extreme caution should be used when conducting LWD disposals on no-till fields in the spring prior to seeding (due to potential effects on seed emergence), and in arid locations, as the potential for salt damage to vegetation is especially high when the soil is dry.

Note: It is the responsibility of the Operator to ensure that drilling waste disposal is conducted in a manner such that it does not impair the productivity of the disposal site.

Table 1. Salinity Criteria Within the Agricultural Land Reserve (Private and Crown Lands)

Depth within the soil profile[a]	Maximum increase in EC (dS/m)	Maximum Soil EC (dS/m)	Maximum Increase in SAR	Maximum SAR
0 – 1 m	1	1.5	1	3
1 m – 1.5 m	2	4	3	8
> 1.5 m	3	5	6	10

0 cm to 1 m: a maximum increase in EC of 1 dS/m and SAR of 1 over background to a maximum post-disposal soil EC < 1.5 and SAR < 3

1 m to 1.5 m: an increase in EC of 2 dS/m and SAR of 2 over background to a maximum post-disposal soil EC < 4 and SAR < 8 crossing of one salt rating category boundary is allowed (i.e. from good to fair)[b]

>1.5 m: an increase in EC of 3 dS/m and SAR of 6 over background to a maximum post-disposal soil EC < 5 and SAR < 10

crossing of one salt rating category boundary is allowed (i.e. from good to fair or from fair to poor) [b]

[a] Soil depth applies to both current and future soil locations (i.e. when recontouring a lease the Operator must ensure that soils that have been subject to waste disposal remain at the appropriate depth in the soil profile.)
[b] see Table 3

Table 2. Salinity Criteria for all other lands in NE BC [fg]

Soil Depth[h]	Disposal Method	Maximum Increase in EC (dS/m)	Maximum Soil EC[a] (dS/m)
Topsoil[b]	LWD, Landspray, Pump-off	1	2
Subsoil[c] to 1 m Good[d] receiving soil	Landspreading	2	3
Subsoil[c] to 1 m Fair[d] receiving soil	Landspreading	1	No limit[e]
Subsoil[c] >1m & ≤ 1.5 m	Mix-bury-cover	2	No limit[e]
Subsoil[c] >1.5	Mix-bury-cover	3	No limit[e]

[a] Some plant species will be sensitive to salinity levels below 2 dS/m (e.g. flax, clover, beans, some wheat varieties, peas, some garden crops, some forest species). Drilling waste disposal must not result in adverse effects.
[b] Topsoil – is the uppermost layer(s) of soil that consists of the L, F, H, O, and/or A horizons or the depth of tillage, whichever is greater, or the equivalent surface soil on a reclaimed site.
[c] Subsoil is the layer of soil directly below the topsoil, that consists of the B and C horizons and extends to bedrock. For salinity management outside of ALR lands, three (3) depths are recognized: top of the subsoil to a depth of 1 metre; subsoil from >1 metre to 1.5 metres; and subsoil at a depth >1.5 metres.
[d] Good and Fair receiving soil categories defined in Table 3 below
[e] No limit – Currently no upper limit is recommended, however, maximum values must be suited to the individual disposal scenario.
[f] SAR criteria have not been defined for lands outside of the ALR. Operators shall ensure that SAR is managed in a way that does not result in impacts to vegetation or soil structure.
[g] NE BC is defined as the area of British Columbia that is located east of the continental divide.
[h] Soil depth applies to both current and future soil locations (i.e. when recontouring a lease the Operator must ensure that soils that have been subject to waste disposal remain at the appropriate depth in the soil profile.)

Table 3. Salt Category Ratings

Parameter		Rating Categories			
		Good	**Fair**	**Poor**	**Unsuitable**
Topsoil[c]	EC dS/m	<2[a]	2 to 4	4 to 8	>8
	SAR	<4	4 to 8	8 to 12	>12[b]
Subsoil[c]	EC dS/m	<3	3 to 5	5 to 10	>10
	SAR	<4	4 to 8	8 to 12	>12

[a] Some plants are sensitive to salts at EC < 2dS/m (e.g., flax, clover, beans, wheat, peas and some garden crops).

[b] Material characterized by SAR of 12 to 20 may be rated as poor if texture is sandy loam or coarser and saturation % <100.

[c] Topsoil: is the uppermost layer(s) of soil that consists of the L, F, H, O, and/or A horizons or the depth of tillage, whichever is greater, or the equivalent surface soil on a reclaimed site.
Subsoil: Subsoil is the layer of soil directly below the topsoil, that consists of the B and C horizons and extends to bedrock.

5.4 Nitrogen Loading

In some cases, landowners may wish to apply nitrogen-containing drilling wastes to land to increase the amount of nitrogen in the soil. Depending on the composition of the drilling waste, either salinity or nitrogen may be the limiting parameter for surface application. An Operator wishing to apply drilling waste to topsoil using an application rate in excess of **50 kg nitrogen** per hectare must notify the Manager a minimum of 2 working days (48 hours) prior to commencing with the disposal and must carry out the disposal in accordance with any further measures specified by the Manager. The notification must contain sufficient information to support the nitrogen loading rates (show a nitrogen deficiency for the type of crop or vegetative cover) and a recommendation from a professional agrologist or forester (as appropriate considering the land use classification of the proposed disposal area).

5.4.1 Mix-Bury-Cover and Landspreading

Disposal of wastes containing greater than 400 kg N/ha is restricted to subsoils of limited permeability, which have a clay content of at least 28%. All other criteria for each disposal option must be followed.

5.4.2 Landspray, Landspray-While-Drilling, Pump-Off

Application rates based on product addition that result in less than 50 kg-N/ha do not require specific nitrogen analyses and should be disposed of according to EC and SAR requirements. The nitrogen application rate may be estimated from equation 1.

Equation (1)
Nitrogen application rate:

$$\text{N Application Rate} = \frac{\text{Units of Product Used x Mass/Product Unit x N in Product}}{\text{Disposal area x 100}} \qquad (1)$$

N Application Rate = Amount of N applied in waste (kg/ha)

Units of product = Number of product containers used (sack/pail/drum)

Mass/product unit = Mass of product in container (kg/container)

N in product = Concentration of N in product (%)

Disposal area = Area to which waste is applied (ha)

All sources of nitrogen must be considered, recycled wastes to include all product additions (e.g. all mud addition on previous and current wells).

6.0 Salinity Management Calculations

6.1 On-Site Disposal Options

Regardless of waste characteristics, drilling wastes must be mixed at a minimum ratio of 3 parts soil to 1 part waste for all onsite disposal options.

6.1.1 Mix-Bury-Cover and Landspreading

For disposal of drilling waste, predictive laboratory mixes shall be used in the following circumstances to determine the mixing ratio needed to achieve the objectives in Table 1 or 2:

1. Disposal by landspreading, when the waste EC is ≥ 8 dS/m or sodium concentration ≥ 2,000 mg/L, or if landspreading will be done onto "fair" receiving soil (see definition of "fair" in Table 3); or
2. Disposal by mix-bury-cover, if the waste EC ≥ 10 dS/m or sodium concentration ≥ 3,000 mg/L.

For on-site disposal of drilling wastes below these thresholds, application rates and mix ratios may either be determined by predictive laboratory mixes or be calculated using the following equations. Regardless of predictive mix or calculation results, drilling wastes must never be mixed at a ratio of less than 3 parts soil to 1 part waste for all onsite disposal options.

6.1.1.1 Mix-Bury-Cover Equations

The application rate for drilling waste shall be based on electrical conductivity.

a) Electrical Conductivity

As an alternative to predictive laboratory mixes, equations 2 and 3 may be used to predict the required mix ratio of soil:waste as a function of electrical conductivity for wastes with an electrical conductivity less than 10 dS/m.

Equation (2)
Oversaturated wastes:

$$\text{Mix Ratio} = \frac{\text{Waste EC x } \Phi}{\text{EC Target Increase}} - 1 \qquad (2)$$

Mix Ratio = Ratio of soil to waste

Waste EC = Electrical conductivity (dS/m) of saturated paste extract

Φ = $\text{Volume fraction of water in waste} = \frac{2.65 - \text{SGfm}}{1.65}$

SGfm = Specific gravity of the field-moist waste measured using an API mud balance

EC Target Increase = the lesser of:

The maximum EC Increase specified in Table 1 or 2 (dS/m), and

[maximum soil EC from table 1 or 2 (dS/m) – background EC (dS/m)]

Equation (3)
Undersaturated wastes:

$$\text{Mix Ratio} = \frac{\text{Waste EC x SLR}}{\text{EC Target Increase x } (1 - \Phi)} - 1 \qquad (3)$$

Mix Ratio = Ratio of soil to waste

Waste EC = Electrical conductivity (dS/m) of saturated paste extract

EC Target Increase = the lesser of:

The maximum EC Increase specified in Table 1 or 2 (dS/m), and

[maximum soil EC from Table 1 or 2 (dS/m) – background EC (dS/m)]

SLR = Ratio of solids to liquid in saturated paste extract of waste

$$= \frac{(SGsp - 1)}{(2.65 - SGsp)}$$

SGsp = Specific gravity of a saturated paste made from the waste, measured using an API mud balance

$$\Phi = \text{Volume fraction of water in waste} = \frac{2.65 - SGfm}{1.65}$$

6.1.1.2 Landspreading Calculations

The application rate for drilling waste shall be based on electrical conductivity and sodium loading rates.

a) Electrical Conductivity

Mix Ratios must first be calculated using Equation 2 or 3. Waste application rate is then calculated by Equation (4).

Equation (4)
Waste application rate:

$$\text{Application rate} = \frac{\text{Tillage Depth x 100}}{\text{Mix Ratio} + 1} \qquad (4)$$

Application rate = Waste application rate (m^3/ha)

Tillage Depth = Depth (cm) of tillage from top of waste layer

Mix Ratio = Ratio of soil:waste (v/v)

b) Sodium

On an interim basis the sodium application rate for landspreading disposals shall not exceed 500 kg/ha.

Sodium based loading rates may be estimated by the following equations:

Equation (5)
Oversaturated wastes:

$$\text{Waste Application Rate} = \frac{500000}{\text{Waste Na Concentration x } \Phi} \qquad (5)$$

Waste application rate = Waste application rate (m^3/ha)

Waste Na concentration = Sodium concentration in waste filtrate (mg/L)

Φ = $\text{Volume fraction of water in waste} = \frac{2.65 - \text{SGfm}}{1.65}$

SGfm = Specific gravity of the field-moist waste measured using an API mud balance

Equation (6)
Undersaturated wastes:

$$\text{Application rate} = \frac{\text{SLR x } 500000}{\text{Waste Na Concentration x } (1 - \Phi)} \qquad (6)$$

Application rate = Waste application rate (m^3/ha)

SLR = Ratio of solids to liquid in saturated paste extract of waste

$$= \frac{(\text{SGsp} - 1)}{(2.65 - \text{SGsp})}$$

SGsp = Specific gravity of a saturated paste made from the waste, measured using an API mud balance

Waste Na concentration = Sodium concentration in waste filtrate (mg/L)

Φ = $\text{Volume fraction of water in waste} = \frac{2.65 - \text{SGfm}}{1.65}$

6.2 Off-Site Disposal Options

Regardless of waste characteristics, the application rate of landspray and landspray while drilling disposals shall not exceed 40 m^3/ha during summer (non-frozen) conditions and shall not exceed 20 m^3/ha during winter (frozen) contitions. Pump-off disposals shall not exceed an application rate of 1000 m^3/ha (10cm depth).

6.2.1 Landspray Calculations

The application rate for drilling waste shall be based on electrical conductivity and sodium loading rates. Drilling waste with an EC greater than 16dS/m must not be disposed of by this method unless the waste is incorporated into the soil.

a) Soil Correction Factor for Electrical Conductivity

Equations 8, 9, 12, or 13 may be used to predict the maximum allowable increase in soil EC (1dS/m or less). In order to ensure that the maximum soil EC is not exceeded, a correction factor must be applied to account for soils that would exceed the maximum allowable EC if a full 1 dS/m increase were applied.

The soil correction factor (SCF) = the lesser of 1, and equation 7

Equation (7)

[maximum soil EC from Table 1 or 2 (dS/m) – background soil EC (dS/m)] (7)

If the calculated SCF is less than one, then it shall be used in equation 8, 9, 12 or 13 to determine the allowable application rate. If the calculated SCF exceeds one, then an SCF of 1 shall be used in applicable equation.

6.2.1.2 Disposal With Soil Incorporation

a) Electrical Conductivity

The following calculations should be used to determine application rate as a function of waste EC.

Equation (8)
Oversaturated wastes:

$$\text{Application rate} = \frac{\text{Tillage depth x } 54}{\text{Waste EC x } \Phi} \text{ x SCF} \qquad (8)$$

Application rate = Waste application rate (m^3/ha)

Tillage Depth = depth of tillage (cm), maximum 10 cm

SCF = the lesser of: 1 and the SCF calculated from equation 7

Waste EC = Electrical conductivity (dS/m) of waste slurry

Φ = Volume fraction of water in waste $= \frac{2.65 - SGfm}{1.65}$

SGfm = Specific gravity of the waste measured using an API mud balance

Equation (9)
Undersaturated wastes:

$$\text{Application rate} = \frac{\text{Tillage Depth x SLR x 54}}{\text{Waste EC x } (1 - \Phi)} \text{ x SCF} \qquad (9)$$

Application rate = Waste application rate (m^3/ha)

Tillage Depth = depth of tillage (cm), maximum of 10 cm

SLR = Ratio of solids to liquid in saturated paste extract of waste

$$= \frac{(SGsp - 1)}{(2.65 - SGsp)}$$

SGsp = Specific gravity of a saturated paste made from the waste, measured using an API mud balance

Waste EC = Electrical conductivity (dS/m) of saturated paste extract

Φ = Volume fraction of water in waste $= \frac{2.65 - SGfm}{1.65}$

SCF = the lesser of: 1 and the SCF calculated from equation 7

For LWD and Landspray, the maximum value that should be used in Equations (8) and (9) for "Tillage depth" is 10 cm, because 10 cm is a reasonably "average" depth of incorporation. Waste applied to cultivated land should be incorporated to the mixing depth before the crop is seeded.

b) Sodium

The sodium application rate shall not exceed 250 kg/ha. Sodium loading rate may be calculated by the following equations.

Equation (10)
Oversaturated wastes:

$$\text{Waste Application Rate} = \frac{250000}{\text{Waste Na Concentration x } \Phi} \qquad (10)$$

Waste application rate = Waste application rate (m^3/ha)

Waste Na concentration = Sodium concentration in waste filtrate (mg/L)

Φ = Volume fraction of water in waste $= \frac{2.65 - \text{Waste Specific Gravity}}{1.65}$

SGfm = Specific gravity of the field-moist waste measured using an API mud balance

Equation (11)
undersaturated wastes:

$$\text{Application rate} = \frac{\text{SLR x } 250000}{\text{Waste Na Concentration x } (1 - \Phi)} \qquad (11)$$

Application rate = Waste application rate (m^3/ha)

SLR = Ratio of solids to liquid in saturated paste extract of waste

$$= \frac{(SGsp - 1)}{(2.65 - SGsp)}$$

SGsp = Specific gravity of a saturated paste made from the waste, measured using an API mud balance

Waste Na concentration = Sodium concentration in waste filtrate (mg/L)

Φ = Volume fraction of water in waste $= \frac{2.65 - SGfm}{1.65}$

6.2.1.3 Disposal With No Soil Incorporation

a) Electrical Conductivity

The following calculations may be used to determine application rate as a function of waste EC.

Equation (12)
Oversaturated wastes:

$$\text{Application rate} = \frac{160}{\text{Waste EC x } \Phi} \text{ x SCF} \qquad (12)$$

Application rate = Waste application rate (m^3/ha)

Waste EC = Electrical conductivity (dS/m) of waste slurry

Φ = Volume fraction of water in waste $= \frac{2.65 - SGfm}{1.65}$

SGfm = Specific gravity of the field-moist waste measured using an API mud balance

SCF = the lesser of: 1 and the SCF calculated from equation 7

Equation (13)
Undersaturated wastes:

$$\text{Application rate} = \frac{\text{SLR x } 160}{\text{Waste EC x } (1 - \Phi)} \text{ x SCF} \qquad (13)$$

Application rate = Waste application rate (m^3/ha)

SLR = Ratio of solids to liquid in saturated paste extract of waste

$$= \frac{(SGsp - 1)}{(2.65 - SGsp)}$$

SGsp = Specific gravity of a saturated paste made from the waste, measured using an API mud balance

Waste EC = Electrical conductivity (dS/m) of saturated paste extract

Φ = $\text{Volume fraction of water in waste} = \frac{2.65 - SGfm}{1.65}$

SCF = the lesser of: 1 and the SCF calculated from equation 7

b) Sodium

The sodium application rate shall not exceed 250 kg/ha. Sodium loading rate may be calculated by the following equations.

Equation (10)
Oversaturated wastes:

$$\text{Waste Application Rate} = \frac{250000}{\text{Waste Na Concentration x } \Phi} \qquad (10)$$

Waste application rate = Waste application rate (m^3/ha)

Waste Na concentration = Sodium concentration in waste filtrate (mg/L)

Φ = $\text{Volume fraction of water in waste} = \frac{2.65 - SGfm}{1.65}$

SGfm = Specific gravity of the field-moist waste measured using an API mud balance

Equation (11)
Undersaturated wastes:

$$\text{Application rate} = \frac{\text{SLR x } 250000}{\text{Waste Na Concentration x } (1 - \Phi)} \qquad (11)$$

Application rate = Waste application rate in m^3/ha

Waste Na concentration = Sodium concentration in waste filtrate (mg/L)

SLR = Ratio of solids to liquid in saturated paste extract of waste

$$= \frac{(SGsp - 1)}{(2.65 - SGsp)}$$

SGsp = Specific gravity of a saturated paste made from the waste, measured using an API mud balance

$$\Phi = \text{Volume fraction of water in waste} = \frac{2.65 - SGfm}{1.65}$$

6.2.2 Landspray While Drilling (LWD)

The application rate for drilling waste shall be based on electrical conductivity and sodium loading rates. Drilling waste with an EC greater than 16 dS/m must not be disposed of by this method. For this disposal method there is no provision for incorporation as the intent of the LWD disposal method is to meet all requirements without the need for incorporation.

a) Soil Correction Factor for Electrical Conductivity

Equation 12 may be used to predict the maximum allowable increase in soil EC (1 dS/m or less). In order to ensure that the maximum soil EC is not exceeded, a correction factor must be applied to account for soils that would exceed the maximum allowable EC if a full 1 dS/m increase were applied.

The soil correction factor (SCF) = the lesser of 1, and equation 7

Equation (7)

[maximum soil EC from Table 1 or 2 (dS/m) – background soil EC (dS/m)] (7)

If the calculated SCF from equation 7 is less than one, then it shall be used in equation 12 to determine the allowable application rate. If the calculated SCF exceeds one, then an SCF of 1 shall be used in equation 12.

b) Electrical Conductivity

The following calculation may be used to determine application rate as a function of waste EC:

$$\text{Application rate} = \frac{160}{\text{Waste EC x } \Phi} \text{ x SCF} \qquad (12)$$

Application rate = Waste application rate in m^3/ha

Waste EC = Electrical conductivity of waste slurry in dS/m

Φ = $\text{Volume fraction of water in waste} = \frac{2.65 - \text{SGfm}}{1.65}$

SGfm = Specific gravity of the field-moist waste measured using an API mud balance

SCF = the lesser of: 1 and the SCF calculated from equation 7

c) Sodium

The sodium application rate shall not exceed 250 kg/ha. Sodium loading rate may be calculated by equation (10):

$$\text{Waste Application Rate} = \frac{250000}{\text{Waste Na Concentration x } \Phi} \qquad (10)$$

Waste application rate = Waste application rate in m^3/ha

Waste Na concentration = Sodium concentration in waste filtrate (mg/L)

Φ = $\text{Volume fraction of water in waste} = \frac{2.65 - \text{SGfm}}{1.65}$

SGfm = Specific gravity of the field-moist waste measured using an API mud balance

6.2.3 Fluid Disposal by Pump-Off

The application rate for drilling waste shall be based on electrical conductivity and sodium loading rates. Fluid with an EC greater than 10 dS/m must not be disposed of by the pump-off disposal method.

a) Soil Correction Factor

Equation 14 may be used to predict the maximum allowable increase in soil EC (1 dS/m or less). In order to ensure that the maximum soil EC is not exceeded, a correction factor must be applied to account for soils that would exceed the maximum allowable EC if a full 1 dS/m increase were applied.

The soil correction factor (SCF) = the lesser of 1, and equation 7

[maximum soil EC from table 1 or 2 (dS/m) – background soil EC (dS/m)] (7)

If the calculated SCF from equation 7 is less than one, then it shall be used in equation 14 to determine the allowable application rate. If the calculated SCF exceeds one, then an SCF of 1 shall be used in equation 14.

b) Electrical Conductivity

The following calculation may be used to determine application rate as a function of waste EC:

$$\text{Application rate} = \frac{1600}{\text{Waste EC}} \text{ x SCF} \qquad (14)$$

Application rate = Waste application rate in m^3/ha

Waste EC = Electrical conductivity of waste (dS/m), maximum 10 dS/m

SCF = the lesser of: 1 and the SCF calculated from equation 6

c) Sodium

The sodium application rate shall not exceed 250 kg/ha. Sodium loading rate may be calculated by equation (15):

$$\text{Waste Application Rate} = \frac{250000}{\text{Waste Na Concentration}} \qquad (15)$$

Waste application rate = Waste application rate in m^3/ha

Waste Na concentration = Sodium concentration in waste filtrate (mg/L)

7.0 Predictive Laboratory Mixes and Confirmation Sampling

Table 4. Predictive and Confirmation Sampling Requirements

Disposal Type	Parameter	
	Waste EC (dS/m)	Sodium (Na)
Pump-off [c]	> 5	> 150 Kg/ha[d]
Landspray [b]	> 10	> 150 Kg/ha[d]
LWD [b]	> 10	> 150 Kg/ha[d]
Landspread [c]	> 8	> 2,000 mg/L[e]
M-B-C 1.0 m – 1.5 m [c]	> 10	> 3,000 mg/L[e]
M-B-C >1.5 m [a]	> 10	> 3,000 mg/L[e]

[a] Predictive sampling only
[b] Confirmation sampling only
[c] Both Predictive and Confirmation sampling required
[d] calculated sodium loading rate
[e] concentration of sodium in waste

Note: Confirmation sampling is required for all drilling waste disposals within the ALR regardless of whether calculations or predictive mixes were used to determine spread rates or mix ratios.

7.1 Predictive Confirmation Sampling Protocol

Where required by this Chapter, post disposal confirmation sampling shall be performed to ensure the EC and SAR of the soil:waste mixture falls within the predicted parameters and there is a uniform mixing of the waste. Confirmation sampling shall be performed as soon as reasonably possible after the disposal event has occurred. The Operator shall prepare a report detailing the results of confirmation sampling and comparing these values to the relevant endpoints for the soil at the disposal site. These reports shall be attached to the Drilling Waste Disposal Summary Form and should be submitted to the Manager within 30 days of the date of confirmation sampling.

7.1.1 Pump-Off

1. The receiving soil sample site must be representative of the soil-landscape in the proposed pump-off area and of the most sensitive part of the soil landscape such as convergent footslopes and toeslopes.

2. A minimum of one sample shall be taken per hectare of the disposal area.

3. The predictive sampling site should be a circular area with a 10 metre radius, with location coordinates identified for subsequent resampling.

4. Ten (10) cores of topsoil per sample are taken randomly within the sample site and a composite made.

5. Composite samples of soil are taken from 0 cm to 10 cm for fine textured soils and 0 cm to 15 cm for coarse textured soils and at all times be above the infiltration front.

6. The soil:waste mix be analyzed for:
    a) pH;
    b) EC;
    c) SAR; and
    d) Na.

7. Confirmation sampling and analysis is to follow the same criteria, use the same locations and be completed within one week following the pump-off or as early as site conditions allow in the spring following a disposal performed during frozen ground conditions.

7.1.2 Landspray and LWD

1. The receiving soil sample site must be representative of the soil-landscape in the proposed pump-off area and of the most sensitive part of the soil landscape such as convergence footslopes and toeslopes.

2. A minimum of one sample shall be taken per 8 hectares of the disposal area.

3. The predictive sampling site should be a circular area with a 10 metre radius, with location coordinates identified for subsequent resampling.

4. Ten (10) cores of topsoil per sample are taken randomly within the sample site and a composite made.

5. Composite samples of soil are taken from 0 cm to10 cm for fine textured soils and 0 cm to 15 cm for coarse textured soils and at all times be above the infiltration front.

8. The soil:waste mix be analyzed for:
    e) pH;
    f) EC;
    g) SAR; and
    h) Na.

6. Confirmation sampling and analysis is to follow the same criteria, use the same locations and be completed within one week following the landspray or LWD operation or as early as site conditions allow in the spring following a disposal performed during frozen ground conditions.

7.1.3 Landspread

1. A minimum of four (4) predictive and confirmation samples are to be collected uniformly throughout the landspread area and shall be representative of the incorporation depth of the landspread.

2. The locations of the predictive sample points are to be identified and recorded so that confirmation sampling occurs at the same points.

3. The soil:waste mix samples be analyzed for:
    a) EC;
    b) SAR; and
    c) Na.

4. Confirmation sampling and analysis of the final soil:waste mix may be carried out at the time of mixing and disposal.

7.1.4 Mix-Bury-Cover (M-B-C)

1. Sampling shall occur within the soil:waste mix below the prescribed depths of greater than 100 cm, or greater than 150 cm.

2. A minimum of six samples shall be taken throughout the sump.

3. The samples are taken at various depths within the sump and located uniformly throughout the sump.

4. The soil:waste mix samples be analyzed for:
    a) EC;
    b) SAR; and
    c) Na.

5. Confirmation sampling and analysis of the final soil:waste mix may be carried out at the time of mixing and disposal.

8.0 Drilling Wastes From pipelines

Freshwater-based drilling fluids are typically used to directionally drill and bore for purpose of pipeline construction. Drilling wastes generated from these activities and other related below-ground boring activities may be managed using the methods set out in this Chapter.

8.1 Storage Pits

Drilling muds and wastes associated with upstream oil and gas pipeline activities stored in earthen entry and exit pits must meet the following requirements:

1. The pits must be constructed in clayey soils which have a clay and fines content of 28 % and 40 % or more, respectively. The clayey soils must extend for at least one metre beyond the bottom and sides of the pits.

2. If suitable soils cannot be located for construction of the entry pit (e.g., deposits of sand or gravel encountered on the entry portion of the drill) any free drilling mud released in the pit must be immediately and continually removed during the duration of the drilling operation unless other mitigative measures (e.g. liners) can be implemented to prevent migration of the fluids.

3. Immediately upon completion of drilling, the drilling waste must be removed from the pits and managed following a method approved in this Chapter and all associated requirements. The pits must then be backfilled and reclaimed.

8.2 Disposal Methods

Landspraying, landspraying-while-drilling, and pump-off can be used to manage drilling wastes generated from associated pipeline activities provided all the requirements of this Chapter, including landowner consent and assessment of the receiving soil, for each specific method are followed. This Chapter requires the mix-bury-cover and landspreading methods to be conducted on subsoils on the well site or remote sump site. In order to manage drilling wastes generated from associated pipeline by these methods, disposal activity is restricted to pipeline-right-of-ways, provided the topsoil has been stripped and conserved, and landowner consent has been obtained. The following requirements also apply:

1. The receiving soil must be assessed to verify that it is suitable to receive drilling wastes and to determine the mix ratio that will prevent the soil/waste mix from exceeding the endpoints set out in Tables 1, 2, and 3. For every 100 m of pipeline-right-of way used for drilling waste disposal, one sample must be taken. The depth at which the samples are taken must correspond to soil assessment requirements set out for

landspreading or mix-bury-cover, as applicable, and the samples analyzed for all parameters specified.

2. The volume and type of mud system must be documented, as well as all of the required information for the specific method used. The licensee of the pipeline must maintain the documentation until the pipeline has been abandoned.