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**STATE OF VERMONT  
AGENCY OF NATURAL RESOURCES  
DEPARTMENT OF ENVIRONMENTAL CONSERVATION  
WASTE MANAGEMENT DIVISION  
SOLID WASTE MANAGEMENT PROGRAM**

**PROCEDURE ADDRESSING GROUNDWATER QUALITY MONITORING  
AND  
RESPONSES WHEN A GROUNDWATER STANDARD IS REACHED OR EXCEEDED  
AT  
MUNICIPAL SOLID WASTE LANDFILLS**

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I. INTRODUCTION

The threat of uncontrolled discharges of leachate from municipal solid waste landfills ("MSWLFs") is significantly reduced by proper siting, design and lined construction of these facilities. However diminished, the threat continues, and it remains necessary to design and implement adequate groundwater monitoring. It is also necessary to develop a coherent strategy for evaluating and responding if groundwater contamination does occur.

On October 9, 1993, the RCRA Subtitle D regulations (40 CFR Part 258) went into effect. The effective date of the regulations was delayed until April 9, 1994, for any existing MSWLF that disposed of less than 100 tons of waste per day. 40 CFR §258.40 contains the federal requirements for design of the landfill liner as well as the determination of the relevant point of compliance for groundwater standards. §258.50 through §258.55 contain the federal requirements for groundwater monitoring systems, and groundwater sampling and analyses. §258.56 through §258.58 contain the federal requirements for the assessment, selection, and implementation of corrective actions if it has been found that groundwater protection standards have been exceeded from the operation of a MSWLF.

Vermont's groundwater quality monitoring and correction action strategy is an integration of the Solid Waste Management Rules (eff. January 15, 1999) ("Rules"), and the Groundwater Protection Rule and Strategy (eff. November 15, 1997) ("Groundwater Rules or GWR").

This procedure supersedes the June 29, 1996, Procedure Addressing Ground Water Quality Monitoring and Ground Water Remedial Action at Municipal Solid Waste Landfills. The revisions bring the Procedure into conformance with the November 15, 1997, version of the Groundwater Rules.

II. Definitions

The following definitions are hereby adopted as part of this procedure and should be referred to as necessary.

*Aquifer* means a geological formation, or a group of formations, or a portion of a formation capable of yielding significant quantities of groundwater to wells or springs.

*Uppermost Aquifer* means the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers that are hydraulically interconnected to this aquifer within the facility's property boundary.

III. Requirements

A. Applicability -- All MSWLFs shall be designed to detect, through appropriate monitoring, the discharge of contaminants from the facility to groundwater. The specifications of the anticipated monitoring program for both the active life and post-closure period shall be contained in the facility management plan. Monitoring requirements shall be contained in the certification for the MSWLF and monitoring shall begin no later than the commencement of facility operations. Monitoring shall continue during active life of the facility and during the post-closure period.

B. Groundwater Monitoring Systems -- Groundwater monitoring systems must consist, at a minimum, of an adequate number of wells installed into the uppermost aquifer to yield samples that:

- (1) represent the quality of groundwater upgradient of all waste management activities on the facility property; and
- (2) represent the quality of groundwater passing the down gradient Design Management Zone (DMZ) boundary, or other point of standards application.

The design of the monitoring well network shall be performed by a qualified professional experienced in hydrogeology and groundwater monitoring. The location, depth, and construction details of each monitoring well, and overall system design shall be determined based upon a thorough characterization of aquifer thickness, and groundwater flow rate and direction, including seasonal and temporal fluctuations in groundwater flow. Also, the monitoring system must be designed with consideration of the saturated and unsaturated geologic units and fill materials comprising the uppermost aquifer and lower confining unit; including thicknesses, stratigraphy, lithography, hydraulic conductivities, porosities and effective porosities. Monitoring well system design shall also be based on the location and design of the facility to be monitored, other waste management activities on the facility property, and the site's operational history.

Unless otherwise required by the Agency, groundwater monitoring wells shall be constructed of two-inch inside diameter Schedule 40 poly vinyl chloride (PVC) casing and screen. Joints shall be flush-threaded. Well screens are to be surrounded with clean, rounded sand or gravel. The annular space above and below the screened portion of the well shall be sealed to prevent contamination of samples and groundwater. Well construction specifications shall be included in the facility management plan.

In the event that any of the water quality monitoring wells established as a part of the approved facility management plan are destroyed or nonfunctional, the permittee shall repair or replace the well(s) prior to the subsequent sampling event.

C. Groundwater Sampling -- Groundwater quality sampling methodology for a MSWLF shall be contained in the approved facility management plan and shall be conditioned in the facility certification. The methodology must ensure accurate, consistent procedures that conclude in monitoring results which are representative of groundwater quality. The sampling plan must include procedures and techniques for sample collection, sample preservation and shipment, laboratory analyses, chain of custody control, and field and laboratory quality assurance and quality control .

Sampling must be performed by qualified personnel and sampling methods must be protective of human health and the environment. The depth to groundwater, as measured from the elevation at the top of each monitoring well casing must be determined immediately prior to well purging and sampling. The groundwater elevation shall be calculated for each well. Monitoring wells must be purged of three well volumes of water, or until evacuated, or until measurements of specific conductance, pH, and temperature stabilize. Specific conductance, pH, and temperature must be determined from all wells subsequent to purging, but prior to sampling.

Background water quality must be established at new MSWLFs and lateral expansions by obtaining a sequence of four or more samples from each monitoring location taken at an interval that ensures that an independent sample of groundwater is collected. The proper sampling interval to establish background water quality shall be determined by considering the effective porosity, hydraulic conductivity, and hydraulic gradient of the aquifer. The proposed sampling interval and parameters to be analyzed for shall be contained in the facility management plan.

During active life and post-closure, sampling shall be performed at a frequency of no less than semi-annually, in May and October, unless otherwise required by the Agency. If any sample is not collected, or a sample is lost or destroyed, the permittee shall document this to the Agency and shall obtain, if possible, a replacement sample within ten days of the original sampling date.

Quality assurance and quality control procedures shall include documentation of all sampling activities. For each routine monitoring event, personnel shall transport one set of volatile organic compound (VOC) trip blanks and collect one equipment blank for all required parameters per sampling event. Duplicate samples shall be collected from ten percent (one as a minimum) of the sampling locations.

D. Groundwater Analyses -- Routine, semi-annual groundwater monitoring requirements shall be contained in the facility certification.

(1) For MSWLFs operational after October 9, 1993, routine groundwater monitoring samples shall be analyzed for:

- Chemical oxygen demand (COD);
- Volatile organic compounds (VOCs) utilizing EPA Method 8260;
- Sodium and chloride; and
- Antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, silver, thallium, vanadium, and zinc.

Groundwater samples shall not be field filtered prior to laboratory analysis.

Antimony, barium, beryllium, cobalt, selenium, silver, thallium, or vanadium may be deleted from the monitoring program if it can be shown that the particular parameter is not reasonably expected to be in or derived from the waste contained in the MSWLF. The methodology for this demonstration is contained in Appendix C of this Procedure. Other analytical parameters, including field filtered samples, may be required based on the waste stream and chemical characteristics of the leachate produced by the specific facility.

(2) For MSWLFs which have closed prior to October 9, 1993, routine groundwater monitoring samples shall be analyzed for:

- Chemical oxygen demand (COD);
- Volatile organic compounds (VOCs) utilizing EPA Method 8260;
- Sodium and chloride; and
- Arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, and zinc.

Other analytical parameters, including unfiltered samples, may be required based on the waste stream and chemical characteristics of the leachate produced by the specific facility.

E. Reporting and Statistical Evaluation -- Within sixty days after the dates of water quality sampling the permittee shall submit to the Agency:

- (1) The laboratory results of all water quality samples.

- (2) Current and historic test results, tabulated by sampling location through time. The tabulation shall highlight concentrations of substances which exceed the primary and secondary groundwater quality enforcement standards and preventive action level, and the Maximum Acceptable Change for Indicator Parameters, as listed in Tables 1, 2, and 3 of Appendix One of the Groundwater Rules for each groundwater sampling location. The other sources of water quality standards information listed in §12-702 of the Groundwater Rules must be consulted for substances which have not had groundwater enforcement standards or preventive action levels established in order to complete this evaluation and list. These sources include US EPA Maximum Contaminant Levels (MCL), or a Vermont Department of Health-issued Vermont Health Advisory (VHA) establishment since the effective date of the Groundwater Rules.
  
- (3) When the data set is large enough, statistical evaluations of all groundwater test results through time for any substances which have been reported to be above a groundwater quality enforcement standard (ES), preventive action level (PAL), MCL, or VHA (collectively, "the standards") using appropriate and justified statistical procedures such as those contained in the Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities - Interim Final Guidance, U.S. EPA, 1989, and Addendum to Interim Final Guidance, July 1992.

The statistical procedure chosen shall comply with the performance standards contained as Appendix A of this procedure.

The statistical evaluation shall include a comparison of groundwater monitoring data to the applicable standard to determine whether, with a 95% level of confidence, the concentration of contaminants statistically exceeds the standard. If the statistical evaluation indicates that the standard has been exceeded, the permittee may perform further statistical analyses to determine whether the data represents a statistically significant increase in contaminant concentration over background levels.

- (4) A narrative assessment performed by a qualified professional of groundwater quality trends for each sampling location. The assessment shall include a preliminary determination of whether standards have been exceeded at a point of standards application, and if so, a preliminary analysis of the cause and significance of the concentration.

The submittal shall be reviewed by the Agency to determine whether all applicable test results have been included in an acceptable format, and revisions may be required. All information shall be considered by the Secretary when making the decision to initiate groundwater reclassification proceedings, issue a public risk advisory, or require a response as provided for in GWR §12-803 or §12-804.

F. Responses When a Groundwater Standard is Reached or Exceeded — If the narrative submitted by the permittee under E.(4) above concludes in a preliminary finding that parameters in groundwater reach or exceed any standard or Maximum Acceptable Change for Indicator Parameters at a point of standards application, the Secretary shall initiate a response in accordance with GWR §12-803 when a PAL is exceeded, or §12-804 when an ES is exceeded. For those substances not listed in Table 1 and Table 2 of the GWR, an MCL, or VHA shall be considered to be an enforcement standard. The determination of the preventive action level for these substances shall be based on the methodology in GWR §12-702(4).

If additional reporting and a proposed response from the permittee is required by the Secretary under GWR §12-803 or §12-804, the report and proposal shall be submitted by a specified deadline of not more than ninety days. The proposal shall contain all information necessary for the Secretary to determine an appropriate response. The proposal shall be based on consideration of the factors identified in GWR §12-803(1) and as appropriate, an analysis of the effectiveness, performance, reliability, ease of implementation, safety concerns, and cross-media impacts of the response. The proposed response shall also include:

- (1) the timeframe of commencement and conclusion of the action;
- (2) a plan for continual reporting to the Secretary the effectiveness of the ongoing action;
- (3) the estimated costs of implementation; and
- (4) a plan for public notification of the proposed response.

In addition to those factors identified in §12-803 when initiating a response the Secretary shall consider, as appropriate, the magnitude of the reduction of risks, the type and degree of long term management required, short term risks that might be posed during implementation of the response, the time to complete the response, the potential for exposure to receptors of the remaining wastes, the reliability of any remedial system, and the potential need for an alternative response. Upon evaluating all relevant information available, the Secretary shall specify the response(s) to be implemented by the permittee, and the timeframes for implementation, which are designed to comply with the goals of GWR §12-804(3). The required response shall be contained in a certification or enforcement order for the landfill.

G. Corrective Action — If the Secretary requires a response from a Permittee to address a violation of a groundwater standard(s), the Permittee shall also demonstrate financial responsibility for performing the response in accordance with the Department of Environmental Conservation's Procedure for Addressing Corrective Action and Financial Responsibility of Corrective Action at Municipal Solid Waste Landfills.

H. Completion of the Response -- Within 30 days of completing the required response, the permittee shall:

- (1) notify the Secretary that the action was successful in achieving the objectives of the response; or in the event the original response was inadequate
- (2) submit a report to the Secretary addressing the cause of and significance of the inadequacy, and propose an alternative response as outlined in section F above.

An evaluation and response flowchart is included as Appendix B.

Effective date

This Procedure is effective upon date of Signature.

Signature

Signature  
\_\_\_\_\_  
Canute Dalmasse, Commissioner  
Department of Environmental Conservation

2/8/99  
Date



Ground Water Monitoring Statistical Method Performance Standards

Any statistical method chosen under the Procedure For Ground Water Monitoring And Remedial Action shall comply with the following performance standards, as appropriate:

(1) The statistical method used to evaluate ground-water monitoring data shall be appropriate for the distribution of chemical parameters. If the distribution of the chemical parameters is shown by the permittee to be inappropriate for a normal theory test, then the data should be transformed or a distribution-free theory test should be used. If the distributions for the constituents differ, more than one statistical method may be needed.

(2) If an individual well comparison procedure is used to compare an individual compliance well constituent concentration with background constituent concentrations of a ground-water protection standard, the test shall be done at a Type I error level no less than 0.01 for each testing period. If a multiple comparisons procedure is used, the Type I experiment wise error rate for each testing period shall be no less than 0.05; however, the Type I error of no less than 0.01 for individual well comparisons must be maintained. This performance standard does not apply to tolerance intervals, prediction intervals, or control charts.

(3) If a control chart approach is used to evaluate ground-water monitoring data, the specific type of control chart and its associated parameter values shall be protective of human health and the environment. The parameters shall be determined after considering the number of samples in the background data base, the data distribution, and the range of the concentration values for each constituent of concern.

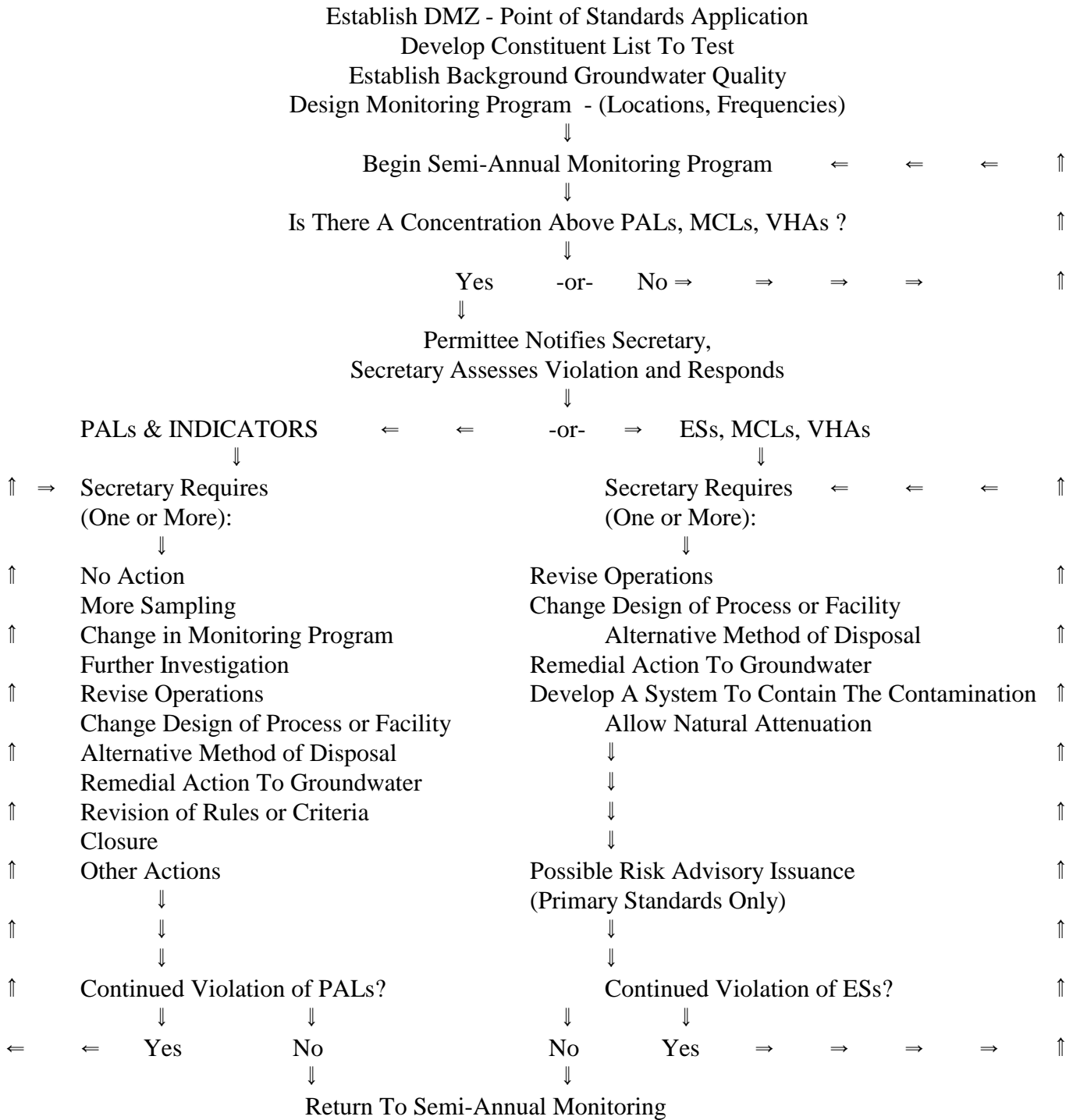
(4) If a tolerance interval or a predictional interval is used to evaluate ground-water monitoring data, the levels of confidence and, for tolerance intervals, the percentage of the population that the interval must contain, shall be protective of human health and the environment. These parameters shall be determined after considering the number of samples in the background data base, the data distribution, and the range of the concentration values for each constituent of concern.

(5) The statistical method shall account for data below the limit of detection with one or more statistical procedures that are protective of human health and the environment. Any practical quantitation limit (pql) that is used in the statistical method shall be the lowest concentration level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions that are available to the facility.

(6) If necessary, the statistical method shall include procedures to control or correct for seasonal and spatial variability as well as temporal correlation in the data.

**SOLID WASTE MANAGEMENT PROGRAM  
PROCEDURE FOR GROUNDWATER MONITORING AND REMEDIAL ACTION**

# EVALUATION AND RESPONSE FLOW CHART



## Appendix C

Section III.D.(1) of this Procedure allows antimony, barium, beryllium, cobalt, selenium, silver, thallium, or vanadium to be deleted from a MSWLF groundwater monitoring program if it can be shown that the particular parameter is not reasonably expected to be in or derived from the waste contained in the MSWLF.

To make this demonstration, four leachate samples, collected semi-annually, must be analyzed for any or all of the metals listed above. If each of the four analyses for any one parameter are less than the concentrations specified below, that parameter may be deleted from the groundwater monitoring program for the remainder of the certification period. Subsequent alteration of the groundwater monitoring program requires written approval of the Secretary.

Metal	Concentration
Antimony	10 ppb
Barium	5 ppb
Beryllium	1 ppb
Cobalt	25 ppb
Selenium	5 ppb
Silver	5 ppb
Thallium	2 ppb
Vanadium	10 ppb