SUBMISSION INSTRUCTIONS NO. 13

GAS MANAGEMENT AND CONTROL SYSTEM FACILITIES

I. APPLICABILITY OF INSTRUCTIONS. These instructions are applicable to all permit applications and permit amendments for sanitary landfills, construction/demolition/debris landfills, and industrial landfills, which must be equipped with a gas monitoring, gas venting or gas control systems. The instructions provided in this section are applicable to facilities that have exceeded the lower explosive limit (LEL) at the facility boundary or are required to implement gas venting and/or control under the provisions of a gas remediation plan. These submission instructions refer to the requirements contained in the Virginia Solid Waste Management Regulations, 9 VAC 20-80-10, promulgated by the Virginia Waste Management Board. *Submission Instructions Number 2* describes the requirements for the design of a landfill. The Gas Management Plan will be provided as an attachment to the Design Report outlined in *Submission Instruction Number 2.* The format of the permit application is outlined in *Submission Instruction Number 1.* This document is not intended to address the requirements of 40 CFR 60.33c and 40 CFR Part 750 (Standards of performance for new and guidelines for control of existing municipal solid waste landfills) and 9 VAC-40-5800. However, documents prepared to meet the federal provisions will be reviewed by the appropriate DEQ Regional Office and will be incorporated into the Gas Management Plan upon completion of the review.

II. GENERAL. [§§ 250.B., 260.B., or 270.B., and 520.A. and 520.B., 9 VAC 20-80-10] Submit three copies of all plans and reports required by the regulations and listed in the instructions shown below. The design must be prepared by a firm registered to practice professional engineering in the Commonwealth and certified by a licensed professional engineer. The title sheet of the design plans must include the following information:

- Project title;
- Preparer of the plans;
- The organization for which the plans were prepared; and
- Location map of the site and the area to be served.

A discussion of the gas management system including a discussion of all calculations must be included in the Gas Management Plan. All calculations, results, and equations must be provided as an attachment to the plan.

III. SITE LAYOUT.

A. General Site Plans. [§§ 520.A.1., 9 VAC 20-80-10] Appropriate drawings as indicated below will be provided for all portions of the gas management system. For those facilities that have a full set of design plans as out lined in *Submission Instruction Number 2* gas management will be addressed, in conjunction with other elements of the facility design in that set of drawings. However, should an existing facility not have a complete set of design drawings all appurtenances associated with gas management will be shown on the following

plans at a minimum:

1. Modification Plans. [§ 520.A.1d, 9 VAC 20-80-10] Show engineering modifications indicating the appearance of the site after installation of all engineering modifications. Include typical cross sections. Gas monitoring probes, vents, extraction wells and any gas controls should be shown on the Modification Plan sheets and the Final Site Topography Plan sheets as applicable. A schedule of the depths of installation for gas probes, vents and extraction wells, as applicable, should be provided in the Modification Plans.

2. Phasing Plans. [§§ 520.A.1f and 520.A.1h, 9 VAC 20-80-10] Show plan and cross-section views of the progression of site development through time. At a minimum, a separate plan must be provided for initial site preparations and for each major phase or new area where substantial site preparation must be performed. If a phased approach is used in the placement of the gas management system it should be shown on the Phasing Plan. The sequencing of gas probes, gas wells and gas control measures may be shown in this manner.

3. Cross Sections. [§ 520.A.1h, 9 VAC 20-80-10]. If cross sections are not provided in the facility permit, provide site cross sections perpendicular and parallel to the site baseline at a maximum distance of 500 feet between cross sections and at points of grade break and construction features. Show the location of the cross sections on the appropriate plan sheets and the sections labeled using the site grid system. Ensure that gas management features have been included in the site cross sections.

4. Final Site Topography. [§ 520.A.1.e, 9 VAC 20-80-10]. Show final site topography indicating the appearance of the site and final contours of the site at closure, including any detail drawings necessary to prepare the site for long term care. The layout of the gas venting or gas collection system should be shown on the plan for final site topography at closure.

5. Site Monitoring Plan [§ 520.A.1.g., 9 VAC 20-80-10]. Show the location of all devices for the monitoring of leachate production, groundwater quality and gas production and venting. This plan shall include a table indicating the parameters to be monitored for the frequency of monitoring before and during site development. The locations, detail drawings and schedules for the construction of the gas monitoring probes should be shown on these plans.

B. General Facility Information. [§ 520.B.1. and 520.B.2., 9 VAC 20-80-10] Submit as a part of the introduction to the Gas Management Plan, the following information:

- Project title;
- Engineering consultants;

- Site owner, permittee and operator.

III. Gas Management Plan. [§§ 520.A.1g. and 520.A.1j., 9 VAC 20-80-10] The Gas Management Plan will describe the design and the procedures for gas monitoring, venting, and control of decomposition gases. The Gas Management Plan shall describe how the facility cap will be protected and how the migration of gases into on-site structures and beyond the facility boundary will be prevented. Once activated, the plan shall ensure that decomposition gases generated at a facility are controlled during the periods of operation, closure and post-closure care to provide for the protection of public health and safety. The Gas Management Plan will provide dimensioned engineering drawings, calculations and specifications, sufficient to fully exhibit the design as an attachment to the Gas Management Plan. The design and planned course of action will be discussed in the Gas Management Plan and supported with engineering calculations as necessary. The drawings and discussion shall address all aspects of the gas management system. To address each of these issues the Gas Management Plan will contain the following elements:

A. Gas Monitoring. [280.B., 9 VAC 20-80-10] The provisions for gas monitoring shall address the design of a system that will be used to determine that the concentration of methane gas generated by the facility does not exceed 25 percent of the lower explosive limit (LEL) for methane in the facility or any offsite structures and does not exceed the LEL for methane at the facility property boundary. Show that the gas monitoring network has been designed to ensure detection of the presence of decomposition gas migrating beyond the landfill property boundary and into facility structures. In the design plans, show probable gas migration paths. Justify these paths in the report by demonstrating that the monitoring network has been designed to account for the specific site characteristics including, but not limited to:

- Local soil and rock conditions;
- Hydrogeological and hydraulic conditions in and surrounding the facility;
- Locations of buildings and structures relative to the waste deposit area;
- Adjacent land use, and inhabitable structures within 1000 feet of the landfill property boundary; and
- Man-made pathways, such as underground construction.

The justification shall be supported by numerical estimates of the gas generation rates during the active life of the facility and during the post-closure care period based on the nature and age of waste and the availability of moisture. Describe data sources, assumptions and methods used to make calculations.

1. Perimeter Monitoring Network.

a. Location. Show the location of the perimeter gas monitoring network at the facility. Monitoring wells shall be located at or near the facility boundary. The applicant may propose an alternate boundary closer to the waste mass requiring fewer wells, based on a knowledge of the site factors. If an alternate boundary is proposed, the plan must show where the applicant will install additional monitoring

wells closer to the facility boundary, or how the operator will implement gas control procedures when compliance levels are exceeded at the alternate boundary. The entire perimeter of the landfill may not warrant the installation of monitoring wells. In this case, the operator shall demonstrate to the satisfaction of the Department that gas migration could not occur along a specific pathway owing to geologic or hydraulic barriers, and that no inhabitable structure or other off-site use of property within 1000 feet of the property boundary are threatened by gas migration.

b. Spacing. Show the spacing of all gas monitoring wells. Justify the proposed plan based upon, but not limited to, the nature of the structure to be protected and its proximity to the refuse. Wells shall be spaced to align with gas permeable structural or stratigraphic features, such as dry sand or gravel, off-site or on-site structures, and areas of dead or stressed vegetation that might be due to gas migration. Generally, the lateral spacing between adjacent monitoring wells should not exceed 250 feet, unless the applicant shows that such spacing would be unwarranted based on the site-specific factors. The spacing between the probes shall be reduced as necessary to protect persons and structures threatened by decomposition gas migration.

c. Depth. Show the depth of each monitoring well boring and each monitoring probe within the bore. The depth of the monitoring well bore shall at least equal the maximum depth of refuse as measured within 1000 feet of the monitoring point. When conditions limit the practicality or do not warrant the well bore depth criteria, the applicant may demonstrate that probes located at alternate depths are sufficient to detect migrating decomposition gas and provide protection to public health and safety, and the environment. All probes shall be installed above the permanent low seasonal water table, above and below perched ground water, and above bedrock. The specified depths of monitoring probes within the well bore shall be adjusted, based on geologic data obtained during drilling, and probes shall be placed adjacent to soils which are most conductive to gas flow. Normally, the number and depths of monitoring probes within the well bore should be installed in accordance with the following criteria:

- A shallow probe installed 5 to 10 feet below the surface;
- An intermediate probe installed at or near half the depth of the well bore; and
- A deep probe at or near the depth of the well bore.

When the depth of the well bore does not exceed 30 feet, the applicant may reduce the number of probes to two, with one probe located in the shallow zone as indicated above, and the other located adjacent to permeable soils at or near the depth of the well bore.

d. Monitoring Well Construction, Show detail and cross section drawing of

typical monitoring wells. Describe the soils and rock units encountered.[1] Provide the following information:

- A facility map showing the location of all monitoring wells. The wells shall be identified with a number that corresponds to the well log. Surface elevations at the wellheads shall be denoted on the map.
- Well logs, including the names of the person(s) logging the hole.
- An as-built description, including a well detail which indicates probe material and depth, extent and type of filter pack, thickness and material used for seals, extent and materials used for backfill, size and interval of perforations, and a description of any shutoff valves or covers.

2. Structure Monitoring. The Gas Management Plan shall address gas monitoring of on-site structures, both adjacent to and on top of the waste mass. The structures include, but not are limited to buildings, subsurface vaults, utilities or any other areas where potential gas buildup would be of concern. The design report shall specify the methods for monitoring which may include, but are not limited to, periodic monitoring utilizing permanently installed monitoring probes, gas surveys, or continuous monitoring systems. Structures located on top of the waste mass shall be monitored on a continuous basis. When practical, structures shall be monitored after they have been closed overnight or for the weekend to allow for an accurate assessment of gas accumulation. Areas of the structure where gas may accumulate shall be monitored and may include, but are not limited to areas in, under, beneath and around basements, crawl spaces, floor seams or cracks, and subsurface utility connections. For safety purposes, oxygen concentrations should be monitored in conjunction with the methane monitoring for structures.

3. Monitored Parameters. All monitoring probes and on-site structures shall be sampled for methane during the monitoring period. Collection of data such as gas probe pressure, ambient temperature, barometric pressure, and the occurrence of precipitation during sampling provides useful information in assessing monitoring results. For example, falling barometric pressure may cause increased subsurface (gas) pressures and a corresponding increased methane content as gas more readily migrates from the landfill. Such transient peaks may prematurely trigger the gas remediation plan.

4. Sampling and Analyses. The Gas Management Plan shall specify the methods used to provide representative samples of formation gases. It shall also specify the equipment and the analytical methods to be used. Normally, measurements are made in the field with a portable methane meter, explosimeter, or organic vapor analyzer. Instruments with scales of measure in "percent of LEL" can be calibrated and used to detect the presence of methane. Instruments of the hot-wire Wheatstone bridge type (i.e., catalytic combustion) directly measure combustibility of the gas mixture withdrawn from the

[1] Use ASTM D-2488 "*Standard Practice for Description and Identification of Soils (Visible-Manual Procedure)*."

probe. The thermal conductivity type meter is susceptible to interference as the relative gas composition, and therefore the thermal conductivity changes. Field instruments should be calibrated prior to measurements and should be rechecked after that day's monitoring activity. Gas samples also may be collected in glass or metal containers for laboratory analysis. Laboratory measurements, with organic vapor analyzers or gas chromatographs, should be used to confirm the identity and concentrations of gas.

5. Monitoring Frequency. [§ 280.C., 9 VAC 20-80-10]. The frequency of monitoring should be sufficient to detect landfill gas migration based on subsurface conditions and changing landfill conditions such as partial or complete capping, landfill expansion, gas migration control system operation or failure, construction of new or replacement structures, and changes in landscaping or land use practices. The rate of landfill gas migration as a result of these anticipated changes and site specific conditions provides the basis for establishing monitoring frequency. The design report shall justify the monitoring frequency selected. Monitoring should be conducted no less frequently than quarterly.

6. Response Requirements. When the results of gas monitoring indicate concentrations of methane in excess of the compliance levels (LEL) the operator must:

- Take all immediate steps necessary to protect public health and safety as required by the contingency plan.
- Notify the Department in writing within five working days of learning that compliance levels have been exceeded, and indicate what has been done or is planned to be done to resolve the problem.
- Verify accuracy of results by reviewing probe readings, possible liquid interference, control well influence, and barometric pressure effects.
- Within 60 days of detection, develop a remediation plan for the methane gas releases and submit it to the Director for approval. The plan must describe the nature and extent of the problem and the proposed remedy.
- As soon as technically practicable, design and construct a gas control system, within a period of time specified in the approved plan. Installation of the system must be in accordance with a design and in a manner approved for construction by the Department.

7. Safety Precautions. The facility operation plan must provide for the actions necessary whenever methane concentrations in excess of the regulatory levels are detected. If methane concentrations are in excess of 25 percent of the LEL (1.25% methane) in facility structures or exceed the LEL (5% methane) at the property boundary, immediate action must be taken to protect human health from potentially explosive conditions. All personnel should be evacuated from the area immediately. Venting the building upon exit (e.g., leaving the door open) is desirable but should not replace evacuation procedures. The sixty-day schedule for submission of a Gas Remediation Plan does not relieve the owner/operator from the responsibility for the

protection of human health and the environment. The owner or operator still must take all steps necessary to ensure protection of human health including interim measures to decrease gas concentrations.

8. Recordkeeping. [§ 280.D., 9 VAC 20-80-10] The design report shall specify how the records of the results of gas monitoring will be kept throughout the active life of the facility and the post-closure care period.

B. Venting and Extraction. [§§ 250.B..8., 260.B.8., 5.4., 520.A.1g, and 520.A.1j., 9 VAC 20-80-10] Gas vents may be either passive or active features. Passive vents allow for the collection of landfill gases from the waste mass and venting of the gases under atmospheric conditions; the effectiveness of a passive venting system is dependent on climatic conditions. Typically, a minimum of 1 passive vent per acre should be installed as a starting point. An active venting system would include a mechanical device (a blower) to ensure effective collection and venting of gas under all conditions. Active gas extraction well spacing should be determined through pump tests conducted in accordance with industry standards. A gas collection system is another component of an active gas extraction system. The collection system may consist of vertical extraction wells (similar to vents), a lateral collection system, or a combination of the two designs. A collection system incorporates piping, valves, sampling locations and mechanical blowers. Gas vents are typically drilled to a depth of approximately 80 percent of the depth of waste at all locations, but can be other depths based on the extraction system design. Vents/extraction wells are constructed with slotted pipe surrounded by a granular material to facilitate collection of gases. The vents/extraction wells must be constructed in a manner compatible with the installation of the final cover system. Show and describe how the construction of the gas venting and mitigation system will:

- Be designed to prevent the migration of concentrated amounts of landfill gases off-site.
- Be located directly below the infiltration layer of the final cover system, above the compacted waste layer, be designed and constructed in accordance with the requirements of this section for a soil venting layer or as a geosynthetic venting layer (which is designed and constructed to effectively perform the equivalent functions of the soil venting layer.) After a general introduction to the design of the gas venting system, provide the following site specific discussion:

1. Peak Flow. Estimate the gas generation rate at the point of expected maximum. Describe data sources and methods used to make the calculations.

2. General System Design Considerations. Describe the design features of the gas collection and removal system (GCRS) and indicate how the system will function when installed.

3. Grading. Describe the criteria that will be used to locate the GCRS. Show that the gas collection media in which the GCRS is to operate is appropriately graded to assure that decomposition gases would be vented to the system.

4. Piping.

a. Riser Pipe. In general, the material used to construct the gas venting riser pipes must be a minimum of six-inch diameter. Gas venting risers must be spaced at a maximum separation of one vent per acre of final cover and installed at a depth of at least three feet into the refuse, unless otherwise approved by the department. Risers must be backfilled with crushed stone or other porous media or other method acceptable to the department. Gas venting risers must be exposed at least three feet above final elevation of the cover system and be fitted with a goose neck cap or other equivalent cap to allow effective venting. The gas venting system must be designed and constructed to operate without clogging. Show the design of the vents and their layout.

b. Pipe Network. If a pipe network will be used to collect decomposition gases, describe the layout and spacing. Provide for gas condensate traps and show their layout. Condensate may be returned directly to the landfill only if the landfill has a composite liner and leachate collection system in accordance with the requirements of the regulations.

c. Piping Strength. Demonstrate that any piping used will have sufficient strength to prevent collapse from anticipated static and dynamic loadings.

d. Sizing. Demonstrate that pipe and pipe perforation sizes are sufficient to allow free gas access to the collection system yet avoid clogging of the perforations and pipes by the collection media.

5. Collection Media. Demonstrate sufficient gradation of collection media and filter materials to allow free gas access to GCRS. Demonstrate that collection media thickness and conductivity allow sufficient venting. The gas venting layer must have a minimum coefficient of permeability of $1x10^{-3}$ centimeters per second, and the gas venting soil layer must be bounded with a filter layer designed to ensure that the effective integrity of the gas venting layer is maintained. Geosynthetic materials can be substituted for granular materials if equivalent performance can be demonstrated. The gas venting layer must be prepared with a minimum thickness of 12 inches.

C. Controls. [§§ 250.B..8., 260.B.8., 5.4., 520.A.1g, and 520.A.1j., 9 VAC 20-80-10]When the results of monitoring in on-site structures or at the facility boundary indicate levels in excess of those specified in § III.A., the owner or operator must take appropriate remedial action. Gas control measures to protect structures, and public health and safety, include one or more of the following: flexible membrane liners, active collection systems, passive collection systems designed to be upgraded to an active system, alarms, ignition source control, utility collars installed within structures and outside in trenches, and ventilation. Gas controls can be used to prevent the migration of gas into facility structures or beyond the facility boundary. Gas controls such as perimeter air injection systems or passive systems,

including cutoff trenches, slurry walls and vent trenches are some of the mechanisms used to prevent the migration of landfill gas. Passive systems must be installed to the depth of permanent low seasonal ground water or keyed into a low permeability layer below the limit of migration. Impermiable geomembranes are used with vent trenches to create a barrier to gas migration.

1. General. Show and describe how the construction of control facilities and operation of a control program at the facility will accomplish the following requirements:

- Prevent methane accumulation in on-site structures;
- Reduce methane concentrations at monitored property boundaries to below compliance levels; and
- Provide for the collection and treatment and/or disposal of decomposition gas condensate produced at the surface. Note that condensate generated from gas control systems may be recirculated into the landfill provided the facility complies with the liner and leachate control systems design requirements.

2. Subsurface gas control systems include, but are not limited to, one or more of the following:

- Active perimeter or interior control systems which are designed to accommodate the maximum expected flow rate from the landfill, and provide access for system monitoring and flow rate adjustment. The control system must be operated to insure that gas is controlled at a sufficient rate without overdraw, to maximize control and not production, and to ensure adequate control for compliance with III.A.
- Perimeter air injection systems which must be installed in native soil between the refuse and the area to be protected. Injection wells may not be located in the refuse. The system must be designed and operated to prevent air infiltration into the landfill but maintain methane concentrations to compliance levels.
- Passive systems, including cutoff trenches, slurry walls and vent trenches, when used must be constructed with an impermeable geomembrane liner. The passive systems must be installed to the depth of permanent low seasonal ground water or keyed into a low permeability layer below the limit of migration.

3. To ensure that the gas control system is operating at optimum efficiency to control decomposition gas, the operator must provide for system monitoring and adjustment.

D. Specifications. [§ 520.B.3a, 9 VAC 20-80-10] Present the specifications for the gas management system and/or gas control system construction as applicable. The specifications must include the materials of construction as well as methods employed to install each component of the gas management and/or gas control systems. The following information should be addressed as applicable:

- Gas monitoring probes;
- Gas vents;
- Gas collection wells;

- Gas collection system;
- Granular collection materials
- All excavations; and
- Other special features.

E. Operations and Maintenance. The maintenance program must include a site-specific operations and maintenance manual maintained and be kept current to reflect any expansion or modifications to the gas control system. An operations and maintenance manual must provide for periodic inspections and servicing of gas control equipment, and operations and maintenance record (retained by the operator).

F. Construction Quality Control. The operator is responsible for providing inspections, as needed, to ensure the integrity of the system. Prior to construction, the designer must obtain and review all applicable test reports, shop drawings, and manufacturer's certificates to verify that all equipment used in the gas control system has been manufactured in accordance with industry standards.

G. Closure and Post-closure Care. The gas monitoring and control program must continue throughout the active life of the facility and the closure and post-closure care periods or until the operator receives written authorization to discontinue by the Department. Authorization to cease gas monitoring and control will be dependent on a demonstration by the operator that there is no potential for gas migration beyond the property boundary or into facility structures. Gas monitoring and control systems must be modified, during the closure and post-closure maintenance period, to reflect changing on-site and adjacent land uses. Post closure land use at the site must not interfere with the function of gas monitoring and control systems.