GUIDANCE DOCUMENT #690

Division of Materials & Waste Management
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Solid Waste Landfill Siting, Permitting and Hydrogeologic Investigation

Ohio EPA's solid waste landfill siting criteria state new municipal, industrial, and residual solid waste landfills cannot be located over critical ground water resources (for example, high-yield unconsolidated aquifers, drinking water source protection areas for public water systems using ground water, and sole source aquifers). The siting criteria also limit the location of new landfills to certain distances from property lines, homes, and natural resources such as parks, streams and wetlands.

In addition to meeting siting criteria, approval of a new landfill depends on the results of a detailed investigation of the site hydrogeology and an evaluation of the proposed facility's design. Numerous characteristics of the site soils, geology, and ground water must be investigated for the proper siting, design, construction, operation, and monitoring of the proposed landfill.

Siting Criteria Frequently Asked Questions

When did Ohio EPA establish siting criteria for solid waste landfills in Ohio?

Ohio EPA's 1976 solid waste rules replaced existing Ohio Department of Health (ODH) solid waste rules that were implemented in 1968. The ODH rules prohibited landfills from being located in areas where waste disposal would constitute a hazard to ground water or surface water resources, or create a health hazard. These included areas near surface waters such as rivers, streams, lakes, flood plains, and in abandoned quarries directly connected to ground water resources.

Ohio EPA's 1976 rules established more stringent siting criteria; and provided protection of ground water resources by prohibiting new solid waste landfills from being located within sand and gravel pits; limestone or sandstone quarries; 1,000 feet of water supply wells; and five feet of seasonal high ground water tables.

How many times has Ohio EPA evaluated and revised the siting criteria rules?

In 1988, the Ohio Legislature passed House Bill (HB) 592, which directed Ohio EPA to revise the 1976 solid waste landfill rules. As part of this effort, the Agency developed siting criteria to better protect ground water resources, and incorporated these criteria into the solid waste rules effective March 1, 1990.

As required by state law (Ohio Revised Code (ORC) Section 119.032), Ohio EPA reviewed and evaluated the siting criteria rules in 1994 and 2003 for possible amendment. As part of the review process, the Agency evaluated pertinent technical publications and information, considered other state's rules, and solicited input from the regulated community, environmental groups, local governments, and citizens. The 1990 siting criteria were not revised during the 1994 solid waste rule revision, while the 2003 and 2004 siting criteria included minor revisions.

Do the siting criteria protect ground water resources?

The current siting criteria address Ohio's unique hydrogeologic settings, water supply needs, and land-use characteristics by limiting the siting of solid waste landfills over sensitive ground water aquifers and providing for appropriate ground water protection setback distances as outlined below. For an overview of siting criteria used in the solid waste and infectious waste programs, refer to DMWM guidance document #693 *Siting Criteria* (*epa.ohio.gov/portals/34/document/guidance/gd_693.pdf*).

- Solid waste landfills cannot be located within sand and gravel pits or limestone or sandstone quarries, or over sole source aquifers or sand and gravel aquifers that yield more than 100 gallons-per-minute (gpm).
- Ground water resources used for public drinking water are specifically protected by prohibiting the location of solid waste landfills within a 5-year time-of-travel for ground water flow to a public water supply well or within a designated drinking water source protection area for a public water system using ground water.

- Solid waste landfills must be located at least 1,000 feet from residential water supply wells and developed springs.
- Solid waste landfills must be located outside of areas where collapse of underground mines may potentially cause ground subsidence.
- Solid waste landfills must be located and constructed so that the base of the landfill (the base of the bottom liner) is isolated from the underlying uppermost aquifer system (UAS) by at least 15 feet of soil or rock, or added geologic material.

These location prohibitions and setback distances collectively provide Ohio's ground water resources a level of protection that equals or exceeds that of the federal solid waste landfill siting criteria and the solid waste landfill siting criteria of Ohio's neighboring states.

What information and documentation did Ohio EPA use to select the solid waste siting criteria that protect ground water resources?

Ohio EPA developed the solid waste siting criteria based on the *Ohio Ground Water Protection & Management Strategy* published by the State of Ohio in October 1986. When developing rules, Ohio EPA also references the *State Solid Waste Management Plan*, most recently published in 2009 (*epa.ohio.gov/Portals/34/document/general/state_plan_2009.pdf*).

The strategy and the plan were written over several years with input from the public, regulated community, and other state agencies. The strategy detailed Ohio's plan for addressing contaminant sources and protecting critical ground water resources. The plan establishes state goals, including criteria for location of solid waste facilities.

How do Ohio's solid waste landfill siting criteria compare with other neighboring and midwestern states?

Ohio's landfill siting criteria are at least as stringent as their counterparts in 10 surrounding states: New York, Pennsylvania, West Virginia, Kentucky, Indiana, Michigan, Illinois, Wisconsin, Minnesota, and Iowa. Ohio EPA's regulations demonstrate a commitment to provide a high level of protection for ground water resources; surface water resources; parks, wildlife, and recreation areas; and neighboring property owners.

A current comparison of these state's regulations shows that:

- Ohio's 15-foot aquifer separation distance and ground water setback criteria for public water supply wells, underground mines, and residential water supply wells collectively provide a level of ground water protection equivalent to or greater than the regulations of the states evaluated.
- With the exception of New York, Ohio is the only state that prohibits the siting of landfills over sole source aquifers and 100 gpm sand and gravel aquifers.
- With the exceptions of New York and West Virginia, Ohio is the only state that specifically prohibits the siting of municipal solid waste landfills in sand and gravel pits or in limestone and sandstone quarries.
- Ohio is the only state with a siting regulation that provides a specific setback distance (1,000 feet from the limits of waste placement) for national and state parks, wildlife areas, and recreation areas.
- Ohio's property line setback for landfills (300 feet from the limits of waste placement) and domicile setback (1,000 feet from the limits of waste placement) exceeds setback requirements in all other states.

Can the director waive the siting criteria?

ORC Section 3734.02 and Ohio Administrative Code (OAC) Rule 3745-27-03 authorize the director to issue exemptions or variances for the siting criteria rules as well as other solid waste regulations. If a landfill permit applicant requests such an exemption or variance, the director must consider and judge the merits of the request with respect to Ohio's solid waste laws. The director is not obligated to grant any exemption or variance request, regardless of its merits. ORC Section 3734.02 and OAC Rule 3745-27-03 require an applicant to justify any siting criteria exemption or variance request. The applicant must demonstrate the waiver is appropriate by providing sufficient evidence through a detailed hydrogeologic investigation.

The director may approve any exemption or variance request that is not likely to cause an adverse impact to human health, safety, or the environment. The natural hydrogeologic conditions at some sites may provide adequate protection to the ground water resources even if the siting criteria are not fully met.

Ohio EPA infrequently issues exemptions for siting criteria requirements, and even then only when a thorough, site-specific investigation has demonstrated that any person generating, collecting, storing, treating, disposing of or

transporting solid wastes or processing scrap tires, as determined by the director, are unlikely to adversely affect the public health, safety, or the environment.

Can developers add or replace existing soil to separate the bottom of the landfill from ground water resources?

Yes. Soil addition or replacement is allowed by the siting criteria rule that requires a minimum 15-foot isolation distance between the base of the landfill liner and the UAS. When soil is added or replaced to separate the bottom of the landfill from the UAS, the 15-foot isolation distance must be maintained. Furthermore, the added or replacement soil must have clay-like properties and be installed in a manner that helps ensure the protection of underlying ground water resources.

Can engineered liners or leachate collection systems satisfy ground water siting criteria requirements?

No. Since 1990, the siting criteria have required that a solid waste landfill's location be protective of the underlying ground water resources, regardless of the landfill's design. Engineered liner and leachate collection systems are used to provide additional ground water protection, and cannot be used to satisfy siting criteria, or to replace the natural protection provided by proper landfill siting.

Permitting and Hydrogeologic Investigation Frequently Asked Questions

What are the steps to obtain a solid waste permit?

The following is a brief description of the steps involved in obtaining a solid waste permit-to-install (PTI):

1. Application received by Ohio EPA
2. Applicant's public meeting (within 35 days of receipt of application)
3. Preliminary application review by Ohio EPA technical staff
4. Ohio EPA public information session (public meeting)
5. Preliminary staff determination to approve or deny PTI
6. Ohio EPA public comment period and hearing (public meeting)
7. Ohio EPA response to comments
8. Final staff determination to approve or deny PTI
9. Director's final decision to approve PTI [opportunity for interested parties to appeal to the Environmental Review Appeals Commission (ERAC) - OR - director's proposed decision to deny PTI (opportunity for appeal under ORC 3745.07)].

For more information describing the PTI process, contact DMWM or see*: www.epa.ohio.gov/dmwm/Home.aspx.*

How does Ohio EPA evaluate the hydrogeologic characteristics of a proposed landfill site?

Ohio EPA's solid waste landfill permitting rules require investigation of site hydrogeology, specifically requesting "sufficient hydrogeologic information to allow the director to identify and characterize the hydrogeology of the UAS and all geologic strata that exist above the UAS."

The hydrogeologic investigation includes the evaluation of existing regional and site-specific hydrogeology, ground water chemistry, and geophysical data (e.g., Ohio Department of Natural Resources publications and maps, water well logs, and oil and gas well logs); a review of residential and public water supply well information; installation of soil borings and monitoring wells; laboratory analysis of soil and ground water samples; and field testing and monitoring to evaluate site ground water characteristics.

A solid waste landfill permit applicant needs to evaluate those characteristics of the site soils, geology, and ground water that Ohio EPA determines to be pertinent for the proper siting, construction, operation, or monitoring of the proposed solid waste landfill. Important site-specific characteristics that are explicitly required by the rules include:

Soil and bedrock characteristics:

- soil or rock type
- color
- moisture content
- layering or interbedding

- weathering
- fracturing or jointing
- mineral content
- thickness
- horizontal extent
- depth and elevation

Ground water characteristics:

- UAS and significant zone of saturation (SZS)
- flow direction and rate
- hydraulic conductivity
- interconnection within UAS, SZS
- ground water level elevation
- temporal (seasonal) fluctuations
- recharge and discharge areas
- yield
- chemistry

What are some of the geologic and hydrogeologic tests performed?

Ohio EPA's solid waste landfill permitting rules require an applicant to use hydrogeologic investigative and testing techniques that are well established and generally accepted by professional geologists and engineers. Hydrogeological testing is based on the installation of soil borings and monitoring wells to collect soil and bedrock samples for field evaluation and laboratory analysis; collect ground water samples for laboratory chemical analysis; and evaluate ground water flow and yield characteristics.

Evaluation of soil and bedrock samples during site investigation includes field description (logging) by the qualified ground water scientist, geotechnical engineer, or soil scientist supervising the drilling and monitoring well installation. In addition, soil samples must be laboratory tested for physical characteristics such as grain size distribution, permeability, porosity, and density.

Ground water flow characteristics are evaluated by monitoring ground water levels and performing accepted field tests that investigate ground water flow rates and aquifer yield. Multiple technical methods must be used during the evaluation of ground water travel time.

How are the results of these tests used to help ensure that ground water resources are protected?

Field and laboratory testing are necessary to understand the site hydrogeology and to evaluate whether certain landfill siting criteria (for example, the100 gpm sand and gravel aquifer restriction) have been adequately addressed. Ground water occurrence and flow characteristics determined from field testing are used in conjunction with ground water quality data from laboratory analysis to ensure proper design and operation of the ground water monitoring system.

How does Ohio EPA evaluate fracture-related ground water flow through soils and bedrock in the vicinity of solid waste landfills?

Ohio EPA's solid waste landfill permitting rules require identification and description of fractures, joints, and other secondary porosity features in soil and bedrock samples from borings and test pits. In addition, the rules require testing and evaluation of ground water flow through soil and bedrock using monitoring wells and piezometers to evaluate the effects of fractures on ground water flow.

Description, testing, and evaluation must be performed in accordance with techniques and methods accepted by professional geologists and engineers, and documented in peer-reviewed technical and scientific publications. For example, Ohio EPA, U.S. EPA, and the American Society for Testing and Materials (ASTM) provide technical guidance documents describing standard practices and methodology for hydrogeologic investigations and ground water sampling. Other sources and publications may also be appropriate.

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Soil and bedrock field descriptions and aquifer testing results from monitoring wells and piezometers must be analyzed to estimate ground water flow directions and rates. All descriptions, results, and analyses must be included in the hydrogeologic report submitted to Ohio EPA for review of a solid waste landfill permit application.

Has Ohio EPA ever requested additional testing to further evaluate fracture-related ground water flow through soils at proposed landfill sites?

Yes. In some instances, Ohio EPA has requested the applicant perform additional hydrogeologic analysis and testing to further evaluate ground water flow through clay soils to ensure protection of human health and the environment.

Some examples of proposed landfill sites where Ohio EPA requested additional testing and investigation to address concerns related to siting criteria and potential impacts to wetlands include Franklin County Landfill, Noble Road Landfill, and Putnam County Landfill.

In the case of Noble Road Landfill, a concern was raised that adjacent wetlands (Fowler Woods) might be dewatered as a result of ground water flow into excavated landfill construction areas underlain by fractured clay till. Ohio EPA added a permit condition requiring the landfill to perform a long-term hydrogeologic investigation of the fractured till to evaluate the effects of the landfill on the adjacent wetlands.

This study was carefully developed and implemented under the direction of Ohio EPA and the Ohio Department of Natural Resources Division of Water. The study was designed to monitor the wetlands during landfill construction and operation through the installation of 36 monitoring wells and regular measurements of ground water and surface water levels. Based on the information compiled, significant ground water flow has not occurred through fractures in the clay till, and landfill construction has not impacted the wetlands.

Has Ohio EPA ever evaluated fracture-related ground water flow through soils on a state-wide basis?

Ohio EPA's Division of Drinking and Ground Waters (DDAGW) completed a study in 1998 (*Correlating Geologic Setting, Engineering, and Ground Water Quality at Hazardous and Non-hazardous Waste Storage, Treatment, and Disposal Sites in Ohio*) that evaluated if correlations exist between observed ground water impacts at solid or hazardous waste treatment, storage, or disposal facilities in Ohio and the facility setting or engineering.

The study results indicated that migration of contaminants into ground water from leaking waste facilities underlain by more than 30 feet of clay soil (till) rarely occurs, regardless of the presence of fractures. In addition, the study showed that liner and leachate collection systems are effective in decreasing the potential for ground water contamination to occur.

DDAGW has also reviewed statewide nitrate concentrations in public water supply wells to evaluate the ground water recharge through clay tills. Where tills are more than 25 feet thick, significantly fewer public water supply wells are impacted by nitrate contamination. This observed relationship appears to indicate that fractures occur less frequently with depth in thick tills, and/or ground water flow through such fractures occurs at very slow rates, if at all.

Has Ohio EPA reviewed any case studies from other states or regions related to the evaluation of potential fracture-related ground water flow effects within soils in the vicinity of solid waste landfills?

Yes. Ohio EPA contacted solid waste regulators and geologic survey and natural resources personnel from New York, Indiana, Michigan, Illinois, Wisconsin, Minnesota, Iowa, South Dakota, and the Province of Ontario, Canada to discuss the permitting, construction, operation, and monitoring of solid waste landfills in clay soils such as till, which commonly exhibit fracturing at shallow depths.

Long-term ground water monitoring has generally indicated that fracture-related ground water flow through underlying clay soils at solid waste landfills does not pose a significant threat to human health or the environment. The general consensus is that such fractures are adequately sealed off through liner installation. Therefore, few case studies have been performed.

The State of South Dakota permitted a lateral expansion of an unlined municipal solid waste landfill (Sioux Falls). South Dakota's decision not to require a bottom liner was based on a hydrogeologic investigation that included a detailed study of fractures in the underlying soil (till) and associated ground water flow. The results of the hydrogeologic investigation indicated that the permeability of the underlying soil (till) is less than the U.S. EPA (Subtitle D) requirement for a recompacted clay soil liner.

How does Ohio EPA's overall approach in evaluating and addressing fracture-related flow through soils in the vicinity of solid waste landfills compare to other states?

A comparison of regulatory and technical approaches to evaluating fractures in clay soil underlying proposed landfills shows that Ohio EPA's overall approach is equally or more protective of ground water resources than those used in other

glaciated northern and Midwestern states. States included in the comparison were New York, Indiana, Michigan, Illinois, Wisconsin, Minnesota, Iowa, and South Dakota, as well as the Province of Ontario, Canada.

During a landfill hydrogeologic investigation, Ohio EPA and nearly all the states referenced require description and analysis of soil samples in accordance with ASTM or the United States Department of Agriculture (USDA) standards. In addition, Ohio EPA and all the referenced states require similar methods and equivalent levels of investigation for soil permeability and ground water occurrence, flow, and yield.

Landfill liner design is important because the liner isolates solid waste and leachate from fractures, joints, sand lenses, or other potential ground water conduits surrounding the landfill, providing additional protection to ground water resources.

Ohio EPA's engineering specifications for municipal solid waste landfill liner construction require that liners be constructed of three to five feet of recompacted clay covered by a plastic liner. The recompacted clay layer is designed to limit vertical ground water flow much more efficiently than thick sections of natural clay till or other types of clay soil.

With the exception of New York, the other states' standards allow for three to five feet of recompacted clay, or do not require installation of a flexible membrane liner for all new landfills or expansions of existing landfills. Under certain conditions, Michigan's and Ontario's landfill standards allow for some landfills to be completed in clay till or other clay soils without the installation of any engineered liner. In such cases, the properties of the underlying soil (typically thick clay tills similar to those present in Ohio) must be capable of preventing the migration of solid waste leachate contamination to underlying or adjacent ground water.

Where do I Find More Information?

Here are some helpful resources related to Ohio EPA's landfill siting criteria and related issues.

Ohio Regulations

For Ohio EPA's solid waste landfill regulations, see: *epa.ohio.gov/dmwm/dmwmnonhazrules.aspx*.

Federal Municipal Solid Waste Landfill Regulations:

40 CFR Chapter 1 Part 258 – Criteria for Municipal Solid Waste Landfills is available at: *www.ecfr.gov/cgi-bin/text-idx?tpl=/ecfrbrowse/Title40/40cfr258_main_02.tpl*.

Ohio EPA Guidance and Policy

Ohio EPA's Technical Guidance Manual (TGM) for Hydrogeologic Investigations and Ground Water Monitoring is accessible at: *www.epa.state.oh.us/ddagw/gw_support.aspx*.

Additional guidance and policy documents are available on request.

Hydrogeology Texts

Applied Hydrogeology, Second Edition by C. W. Fetter (Copyright 1988 by Macmillan Publishing Company)

Groundwater by R. Allen Freeze and John Cherry (Copyright 1979 by Prentice-Hall, Inc.)

Web Sites

Illinois:	*www.epa.state.il.us/*
Indiana:	*www.in.gov/idem/*
Iowa:	*www.iowadnr.gov/Environment/LandStewardship/WasteManagement.aspx*
Kentucky:	*waste.ky.gov/Pages/default.aspx*
Michigan:	*www.michigan.gov/deq/0,4561,7-135-3312_4123---,00.html*
Minnesota:	*www.pca.state.mn.us/index.php/waste/index.html*
New York:	*www.dec.ny.gov/about/638.html*
Pennsylvania:	*www.portal.state.pa.us/portal/server.pt/community/waste/6006*
South Dakota:	*denr.sd.gov/des/wm/sw/swmainpage.aspx*
West Virginia:	*www.dep.wv.gov/WWE/Programs/solidwaste/Pages/default.aspx*

Wisconsin: *dnr.wi.gov/topic/Landfills/Siting.html*

Ontario: *www.ontario.ca/environment-and-energy/landfill-standards-guideline-regulatory-and-approval-requirements-new-or*

ASTM: *www.astm.org*

U.S. EPA: *www.epa.gov/epawaste/nonhaz/index.htm*

Contact

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