

Guidance for Liner Design for Demolition Debris or Industrial Solid Waste Landfills

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INTRODUCTION

In Minnesota, ground water is owned by the people of the state until it is pumped out. Ground water is a valuable resource and its quality must be protected. The purpose of the state statutes and Minnesota solid waste management rules for landfills is, in part, to establish facility design and operating standards that, when properly followed, prevent human exposure to contaminated drinking water, prevent contamination of surface water, and preserve ground water for future uses.

Groundwater contamination has happened down-gradient from some unlined landfills. The statutes and rules prohibit the placement of landfills in areas that, if contaminants were to leak from the facility, would result in groundwater contamination. Restricted locations include: karst topography, flood plains, sites over valuable water resources, and other areas likely to result in groundwater contamination such as zones of high permeability. However, the rules leave the MPCA Commissioner with considerable discretion to set location, design, and operational requirements for landfills.

Unlike the case with mixed municipal solid waste (MSW) and MSW combustor-ash landfills, for demolition

debris and industrial solid waste landfills liners are not required in all cases. While the exercise of discretion has been on some occasions a source of controversy between MPCA staff, citizens, and the regulated community,



*Demolition Cell at the Fergus Falls Landfill.
Photo by Kathy Holland-Hanson*

the exercise of judgment is appropriate because many variables relate to location and site specific conditions. These variables include, but are not limited to, site geology, groundwater flow, receptor locations, receptor types, future land use plans, future groundwater use plans, adjacent uses, surface water locations and local shoreland requirements, costs, alternative waste management options, changes in technology and waste streams, local industry, air emission issues, and incoming waste types. For now, the MPCA and the regulated community will be working with rules

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that allow the commissioner some level of discretion.

This guidance is intended to identify a minimum level of effort if it is determined that a liner is warranted at A demolition debris or industrial solid waste landfill.

DEMOLITION DEBRIS LANDFILLS

The MPCA Demolition Landfill Guidance, August 2005, (Guidance) was developed to assist MPCA staff, regulated parties, and consultants in using their professional judgment in the application of the Solid Waste Rules for demolition debris landfills. The guidance should be applied on a case-by-case basis given the facts of the individual site, and is not intended to be prescriptive. The goal is to achieve best management practices (BMPs) given the unique circumstances, and to help all parties make sound and predictable judgments. This should make the application of existing rules easier and more effective for government and the regulated community.

The Guidance requires that all demolition landfill meet the location standards as set forth in rule, and conduct adequate site evaluations to determine the soil and ground water characteristics at the site. The Guidance establishes three classifications for demolition landfills dependent upon wastes accepted at the facility and set forth waste screening criteria. The Guidance provides decision matrices for determining when ground water monitoring and/or liners should be required at demolition landfills. This document, is a guidance that sets forth the minimum standards for liner design should it be determined that a liner is necessary.

INDUSTRIAL SOLID WASTE LANDFILLS

There are two types of industrial solid waste landfills in operation in Minnesota – general industrial landfills which accept many different types of industrial solid wastes, and industrial monofills which accept only one type of industrial waste or a limited number of wastes from a specific industrial plant. In general, the constituents of concern that may leach from industrial wastes has lead to the MPCA to require liner systems at most, if not all, industrial landfills. However, the same principals used in siting and designing demolition debris landfills as described

above can be applied to industrial solid waste landfills.



*Liner Construction at Otter Tail Power Company's Hoot Lake Landfill.
Photo by Kathy Holland-Hanson*

DESIGN RECOMMENDATIONS

The liner system design should include items A to I below.

- A. The lined portion of the landfill should be designed to collect any water movement from the unlined fill area to the lined fill area, and to prevent movement of water from the lined fill area to the unlined fill area.
- B. The liner system must be compatible with the types of waste accepted and the anticipated leachate they would generate.
- C. The liner should maintain its integrity for the operating life of the facility and the post-closure care period.
- D. The liner should be designed to have a leachate collection efficiency of at least 90 percent of the precipitation falling on the fill area based on running the USEPA HELP (Hydraulic Evaluation of Landfill Performance) Model (or other appropriate model) in the open, operating condition. Assumptions used in the HELP model calculation must be carried through to the design specifications. The efficiency calculation must consider the liner thickness, the liner slope, the saturated hydraulic conductivity of the liner and drainage layer, the drainage layer thickness, the

permeability of the drainage layer and liner, the porosity of the drainage layer, the flow distance to collection pipes, and the amount of leachate to be generated and collected based on annual infiltration and ground water inflow. The liner design for the side slopes of the fill area may vary from the design for the base slope for constructability reasons, however, the overall efficiency of at least 90 percent applies to both side slopes and base slopes.

- E. The liner system should consist of at least the following:
 - (1) a smooth, stable subgrade for placement of the barrier liner. This is achieved by removing abrasive objects, organic matter, and vegetation in the subgrade, and regrading, or by placing a protective material over the existing subgrade;
 - (2) a barrier liner capable of containing leachate generated at the facility and surface water that has come in contact with waste; and
 - (3) a drainage layer above the barrier liner to rapidly convey surface water and leachate from the fill area, and to protect the barrier layer from puncture or other disturbances that might disrupt the integrity of the barrier liner.
- F. The base of the liner should be graded as necessary to completely drain leachate from the fill area.
- G. A soil barrier layer should be compacted in loose lifts no greater than eight inches and the loose lift of the soil should not be any greater than the height of the feet on the compactor.
- H. The drainage layer must cover the base liner and the side slopes. The drainage layer should be at least 12 inches thick. Depending on the nature of the waste, a thicker sand drainage layer should be considered if a synthetic membrane is used as the barrier layer, or a graded aggregate filter or filter fabric may be employed to further protect the barrier layer if a minimum 12 inch drainage layer is proposed.
- I. The design of the liner system should be described in the engineering report, and should address the following items:

- (1) the basis on which the chosen liner design was selected
- (2) the source and quantity of natural soils capable of meeting the design requirements;
- (3) the composition of the drainage layer and liner including the soil gradations, percent fines, mineral composition, and solubility under acidic conditions and when in contact with solvents;
- (4) the calculations and assumptions used in the design proposed for the facility;
- (5) design specifications for all materials proposed to be used in the construction of the liner system; and,
- (6) a quality control/quality assurance (QA/QC) program identifying the testing requirements (type and frequency) for ensuring the materials used to construct the liner system conforms to the design specifications. Tests to be conducted must be appropriate to verify that the assumptions used in the design analysis (coefficient of permeability, soil classification, thickness, etc.) have been achieved.

LEACHATE DETECTION, COLLECTION AND TREATMENT

If a liner is required at a landfill, the facility design should also include a leachate head and leak detection, collection, and on-site or off-site treatment system. The detection system should monitor the level of leachate build-up in the fill area (leachate head monitoring) and the effectiveness of the liner system (leak detection monitoring). The collection and treatment system must collect the leachate for proper treatment. If leachate treatment will take place off-site, pretreatment of the leachate must be provided, if necessary. The system should include items A to N.

- A. A leachate head monitoring system should be installed at the lowest elevation of each cell or phase within the fill area and throughout the fill area, as necessary, to monitor leachate

- build-up. The detection system must consist of materials compatible with the leachate.
- B. A leak detection system should be installed beneath the lowest elevation of each cell or phase within the fill area. If a leachate collection sump is included in the design, the leak detection system should underlie the entire sump area. The leak detection system shall monitor the effectiveness of the liner system. As an alternative to the installation of lysimeters, the MPCA will consider the addition of a geosynthetic clay liner (GCL) in the sump and leachate collection trench areas in conjunction with performing electronic leak detection testing of these areas.
- C. A clean-out system capable of cleaning the entire collection system should be constructed as part of the leachate management system. Clean-out structures should be spaced no more than 500 feet apart, unless it can be demonstrated that appropriate equipment is available to clean out longer distances.
- D. The size of the collection system should be designed as follows.
- (1) A water balance calculation should be completed based upon the amount of precipitation, evapotranspiration, surface run-off, soil and waste moisture storage capacity, root zone depth, surface slope, subsurface lateral drainage, and average monthly temperature. The leachate generation rate should be derived by calculating the amount of water that percolates through the cover each month using actual data from an average weather year and a year when the precipitation exceeds the average precipitation by at least 20 percent. The engineering design report should contain all calculations and assumptions made during the water balance calculation. The USEPA HELP Model is accepted as a tool for use in calculating the water balance at a landfill
 - (2) The size of the fill area the collection system will serve must be considered in determining pipe and storage area sizing.
 - (3) The amount of leachate to be collected must relate to the water balance calculated in subitem (1) and any applicable liner efficiency requirements.
 - (4) In sizing sump pumps to remove leachate from the fill area, consideration should be given to the storage capacity anticipated in the waste and leachate collection system, the anticipated amount of leachate to be generated, and the amount of leachate moving to the holding area by gravity drains. The pumps must be compatible with the leachate.
- E. A leachate storage tank must be designed and constructed to drain tank overflow back into the overall leachate collection system to minimize the potential for overfilling of the storage tank. The storage design must be capable of detecting leaks, containing the leaks, and minimizing the need for corrective actions. For this reason, it is recommended that storage tanks be doubled-walled.
- F. The height of free standing liquid over the liner in the fill area should not exceed one foot or the maximum depth of the sand drainage layer, whichever is less.
- G. The unintercepted leachate flow distance along the drainage layer should not exceed 100 feet. A greater distance may be used if it can be shown that the maximum head on the liner will conform to item F above.
- H. The design of the collection system should include collection pipes of sufficient diameter to handle the flow and allow cleaning. The pipes must be capable of handling loads experienced during construction and disposal of solid waste. The engineering design report should contain the buckling capacity and compressive strength of the pipe. The pipes should be placed in lined trenches and covered with a suitable granular filter material or geotextile designed and constructed to encourage flow to the pipe and prevent infiltration of fine-grained soils.
- I. The collection pipes should be trenched into the barrier liner with the same thickness of liner beneath the pipes as exists elsewhere.

- J. The collection system should consist of pipes resistant to chemical and biological breakdown as a result of contact with the leachate.
- K. The design and construction of the collection system should be coordinated with the planned phase development for the site and the amount and timing of leachate generation.
- L. The collection system should be designed to allow the collection of leachate samples for chemical analysis.
- M. The collection system should be designed to allow for transportation of leachate into a holding area for testing and treatment prior to disposal, if the holding area is necessary. Any holding area or treatment system should be designed to be compatible with the leachate and capable of preventing releases of leachate to the environment. The treatment and disposal of leachate must comply with Minnesota Rules parts 7001.0010 to 7001.0210, and 7001.1000 to 7001.1100.
- N. Leachate transmission lines outside of the lined area should consist of double-walled pipe to provide leak detection and containment.
- D. Tests for compaction, Atterberg limits, grain size distribution, permeability, field moisture density and as-built thickness, should be completed on soil components of the liner to ensure the requirements of the approved plans and specifications have been met. Tests to be conducted must be appropriate to verify that the assumptions used in the design analysis (coefficient of permeability, soil classification, thickness, etc.) have been achieved. The owner or operator should retain a portion of the field-molded and field-compacted samples of the liner system layers until the construction certification is complete.



Liner construction at the Morrison County Landfill.

Photo by Kathy Holland-Hanson

CONSTRUCTION RECOMMENDATIONS

The MPCA recommends that the following construction techniques be incorporated into the project specifications for all major design features.

- A. The construction observer should record all procedures completed during construction at the landfill to document that the design features were constructed in accordance with the approved plans and specifications. This record should include pictures, field notes, and all test results.
- B. A permanent on-site survey control point providing horizontal and vertical datum should be installed and its location shown on the facility as-built plan.
- C. As horizontal phases are installed, the liner must be joined to existing liners.
- E. Geomembrane liners must be installed during dry conditions. The seams joining membrane panels must be inspected as construction proceeds. Seams should be tested using acceptable testing methods and field seams must be tested for tensile strength. All flexible membranes should be protected after placement. The soil layer above and below the barrier layer must be free of roots, sharp objects, rocks, or other items that might puncture the liner. In addition, the commissioner may require the owner or operator to perform electro-conductivity testing to ensure the quality of the in-place synthetic membrane.



*Liner construction at NE Otter Tail Landfill.
Photo by Kathy Holland-Hanson*

- F. Barrier liners constructed of in-situ soils should be formed by scarifying and recompacting these soils throughout their full minimum design thickness in lifts not to exceed eight inches or the depth of the sheeps foot compactor, whichever is less.
- G. All pipes exiting the lined area should be fitted with anti-seep collars and must consist of double-walled pipe to provide for leak detection, containment and collection.
- H. Vegetative growth on liners should be prevented.
- I. Soil materials for the liner must be surveyed and staked during placement. A final survey must be conducted when liner construction is complete to document final slopes and elevations.

OPERATING CONSIDERATIONS

If it is determined that a liner is required at a landfill, any previously unfilled cell or phase of the existing landfill or any portion of a new landfill must be lined.

The liner system should be protected from damage during operation of the facility by a method approved by the commissioner.

Enough waste or other approved material should be placed over the lined area by December 1st following construction to reduce the likelihood of the liner being impacted by freeze/thaw actions.

CONTACT INFORMATION

For more information on demolition debris landfills, contact the solid waste engineer the assigned to the region in which your facility is located.

Duluth:	Brett Ballavance (218)723-4837
Brainerd:	Dan Vleck (218)855-5007
Detroit Lakes:	Kathy Holland-Hanson (218)846-0470
Marshall/Wilmar:	Tony Bello (651)296-7272
Rochester:	Sherri Nachtigal (507)280-2997
Metro:	Mike Lynn (651)296-8584 Geoff Strack (651)296-7716

For more information on industrial solid waste landfills, contact Bob Criswell at (651)296-870 or Julie Henderson at (651)296-8596.