Minnesota Pollution Control Agency

Guidance for Industrial Waste Management Evaluation Model (IWEM)

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INTRODUCTION

The purpose of the state statutes and Minnesota solid waste management rules for landfills is to prevent human exposure to drinking water contamination, prevent contamination of surface water, and preserve groundwater for future uses. In Minnesota, groundwater is owned by the people of the state until it is pumped out.

The rules prohibit the placement of landfills in areas that 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. Groundwater contamination has happened down-gradient from some unlined landfills.

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, 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, the exercise of judgment is appropriate because many variables relate to location and site specific decisions. 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, MPCA and the regulated community will be working with rules that allow the commissioner some level of discretion.

This guidance will focus on the United States Environmental Protection Agency (USEPA) Industrial Waste Management Evaluation Model (IWEM) which is one model that is available to help facilities determine whether a liner is warranted, and, if so, to evaluate the adequacy of a liner design. This model may be used to assist facilities in the design of liner systems for either industrial or demolition debris landfills in Minnesota.

BACKGROUND

In February 2003, the USEPA introduced a new computer modeling tool as part of the Guide for Industrial

Waste Management which includes the IWEM User's Guide and Technical Background Document. The IWEM Guide was developed by USEPA and twelve state environmental agencies. The IWEM Guide recommends Best Management Practices (BMPs) to protect water and air and offers a risk-based approach to liner system designs.

IWEM is intended for facility managers, regulators, and citizens as a simple-to-use tool to evaluate appropriate liner systems for:

- Landfills;
- Surface impoundments;
- Waste piles; and
- Land application.

IWEM

A copy of the IWEM may be obtained from the USEPA at the following web site: www.epa.gov/epaoswer/non-hw/industd/index.htm. The IWEM is a voluntary guide to recommend a baseline protective design and operating practices to manage nonhazardous industrial wastes throughout the country. The IWEM adopts a multimedia, risk-based approach to protect human health and the environment and recommends BMPs. Key factors that are considered include:

- protect ground water, surface water, and ambient air quality in siting, designing and operating landfills;
- monitor a landfill's impact on the environment;
- determine necessary corrective actions;
- close a landfill; and,
- provide post-closure care.

IWEM provides the results of fate and transport modeling of constituents (chemicals) in leachate through subsurface soils to ground water and beyond (to prescribed wells). It utilizes the USEPA Composite Model for Leachate Migration with Transportation Products (EPACMTP). The EPACMTP is not a new tool. It was developed to support risk-based ground water assessments under the Resource Conservation and Recovery Act (RCRA). It has been used for several years in many other USEPA applications.

The IWEM identifies the following evaluation tiers:

- Tier 1 - screening analysis, based on national data;
- Tier 2 - location-adjusted, based on inputting limited site specific data; and,
- Tier 3 - not in model but see the Guide.

The IWEM model compares expected leachate concentrations entered to leachate concentration threshold values chosen. USEPA's Maximum Contaminant Levels (MCLs) and Health-Based Numbers (HBNs) are built in to the model. The Minnesota Department of Health's Health Risk Limits (HRLs) may be input into the model during a Tier 2 analysis.

The model provides four types of recommendations:

1. Minimum protective liner based on leachate only;
2. Alternative protective liner based on leachate and location data;
3. Maximum concentration levels protectively managed; and
4. Wastes that can be protectively land applied.

TIER 1 EVALUATION

All facilities should first run the Tier 1 evaluation. For the Tier 1 evaluation, you must identify the constituents of concerns for the waste you are disposing, and enter the expected leachate concentrations for each constituent of concern. The IWEM then determines a minimum recommended liner design that is protective for all waste constituents using Monte Carlo analysis. The Monte Carlo analysis determines the probability that the release of leachate would result in a ground water

concentration exceeding regulatory or risk-based standards. The Tier 1 evaluation will recommend one of three liner scenarios: no liner is needed to be protective; a single liner is indicated; or, a composite liner is indicated.

There are two default liner system designs in the IWEM. The single liner system is based on three feet of compacted clay with a maximum hydraulic conductivity of 1×10^{-7} cm/sec. The composite liner system consists of a 60 mil high density polyethylene (HDPE) synthetic membrane over either 3 feet of compacted clay with a maximum hydraulic conductivity of 1×10^{-7} cm/sec or a geosynthetic clay liner (GCL) with a maximum hydraulic conductivity of 5×10^{-9} cm/sec.

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

This does not mean that the MPCA is considering limiting liner designs to the default liner systems in the IWEM. If the Tier 1 evaluation indicates that a liner system is warranted, a liner system should be proposed and a Tier 2 evaluation should be conducted to help determine the adequacy of the proposed liner system.

The Tier 1 analysis uses only the expected leachate concentrations in the waste and a generic database of national data. It applies the most stringent controls available in the model. The recommended IWEM liner is designed to be protective at 90% of sites.

TIER 2 EVALUATION

In the Tier 2 evaluation, you may input more detailed site specific information resulting in a more precise assessment of the landfill. You can also evaluate various other liner system designs to determine their adequacy in protecting the environment and support their use. The IWEM relies on the infiltration rate of the proposed liner system in conducting the Tier 2 evaluation.

To run the Tier 2 analysis a limited amount of site-specific data must be entered into the model:

- Area, depth, and location (climate) of the facility;
- Distance to surface water;
- Distance to the nearest well;
- Depth of the base of the landfill;
- Life of the landfill;
- Waste type;
- Infiltration rate of the proposed liner system;
- Unsaturated zone soil type; and
- Hydrogeologic data: hydraulic conductivity, hydraulic gradient, ground water pH, sorption coefficient and biodegradation rate.

The EPACMTP models attenuation and bio-chemical transformation based on constituent-specific organic carbon partition coefficients. It uses the Monte Carlo simulation (repeated random sampling) to determine probability distribution of predicted ground-water concentrations.

INFILTRATION RATE

The infiltration rate used in the Tier 2 evaluation is an adaptation of Darcy's equation.

$$Q = KA \frac{dh}{dL}$$

For the IWEM, you must enter the anticipated infiltration rate per unit area (Q_A) for your proposed liner system design. The IWEM uses metric units, so the unit area is set at 1 square meter (m^2) and A, area drops out of the equation. Q_A is entered in units of meters/year (m/yr).

For compacted clay liners Q_A is calculated using the following equation:

$$Q_A = 315{,}360\ k \frac{h}{L}$$

where,

k = hydraulic conductivity, cm/sec

L = liner thickness, feet

h = maximum head on the liner + L = 1 + L, feet

For GCLs and synthetic membranes, Q_A should be obtained from the manufacturer.

In designing a proposed liner system, you may use the HELP model to predict the infiltration rate. To evaluate an existing liner, it is recommended that in-field leak detection system flow rates be used.

APPLICABILITY TO DEMOLITION DEBRIS LANDFILLS

USEPA states that the IWEM is not recommended for use at demolition debris landfills. The reason for this is that representatives from the demolition debris landfill group were not represented in the development of the model. However, the MPCA has determined that there is no reason why the principles could not be applied to demolition landfills.

The IWEM could be used at demolition debris landfills to assist in designing a protective liner system, if required, or to assess the adequacy of the site or the proposed liner for acceptance of industrial wastes at the facility.

The MPCA is developing a separate demolition landfill guide to set consistent standards that identify when additional information is needed prior to designing a landfill. The IWEM is a tool that can be used to assist in landfill liner design

One drawback to using the IWEM in this manner is that typical demolition landfill leachate is needed to run the IWEM. As part of the last demolition debris landfill rule revision attempt, the MPCA collected existing groundwater monitoring and leachate data from demolition landfills. The MPCA is attempting to compile a list of demolition landfill leachate parameters and typical concentrations. However, most of the data we have is based on ground water monitoring, not leachate, and the leachate data we have is representative of the commingling of construction and demolition debris rather than just demolition debris on its own.

LIMITATIONS ON LINER DESIGN

One thing to keep in mind when running the Tier 2 analysis for an alternative liner design, the alternative liner is only represented by inputting an infiltration rate into the IWEM. It does not consider what type of liner system – whether it is a single or composite liner, or of what type of materials the liner system consists (compacted clay vs. synthetic membrane, etc.). For a single soil liner system you can calculate the infiltration rate using the modified Darcy's equation discussed earlier. For composite liners, you will need to use one of Giroud's equations.

Also, the IWEM will not accept a situation where the base of the landfill is below the water table – the model recommends that a Tier 3 analysis be conducted. Therefore, the IWEM is not an applicable tool for evaluating in-gradient liner systems.

APPLICABILITY TO DETERMINING INDUSTRIAL WASTE ACCEPTANCE

In developing an Industrial Solid Waste Management Plan (ISWMP), facilities need to identify the criteria they plan to enforce prior to waste acceptance. The IWEM may be used to determine whether the proposed criteria will result in protective disposal at the facility by inputting the acceptance criteria and the liner system information into the model.

LIMITATIONS TO EVALUATING WASTE ACCEPTANCE CRITERIA

The IWEM assumes that the entire landfill is composed of waste with the leachate characteristics that you input. Therefore, if a certain waste is only going to be 5% of the total landfill volume, somehow a weighted average of the leachate would need to be generated for the IWEM to provide better representative results.

CONTACT INFORMATION

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

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