WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY
SOLID AND HAZARDOUS WASTE DIVISION

SOLID WASTE GUIDELINE #19

"Hydrologic Evaluation of Landfill Performance (HELP) Model"

1.0 Introduction

This guideline is intended to provide guidance on the use of the Hydrologic Evaluation of Landfill Performance (HELP) Model. The HELP Model was developed by the United States Army Corps of Engineers with support form the United States Environmental Protection Agency (EPA) in order to provide landfill designers and regulators with a tool for conducting water balance analyses of landfills, cover systems, and other solid waste containment facilities. The primary purpose of the model is to assist in the comparison of design alternatives. Version 3.07 of the HELP model (DOS version) (EPA/600/R-94/168a, Sept 1994) may be downloaded from the internet site for the U.S. Army Corps of Engineers Waterways Experiment Station at http://el.erdc.usace.army.mil/index.cfm . Visual HELP, a Windows interface for HELP, may be purchased through a variety of software vendors.

2.0 Regulatory Considerations

The HELP model is required as part of a demonstration to request suspension of groundwater monitoring requirements under Chapter 2, Section 6 of the Solid Waste Rules and Regulations (SWRR). In addition, the Department has determined that the HELP model is a useful tool (when combined with other information) when evaluating prescriptive final cover specifications, under Chapter 2, Section 7(d), and when trying to make a demonstration that an engineered containment system, under Chapter 2, Section 4(j) is not necessary. Lastly, HELP modeling is an integral part of evaluating alternative landfill designs and conducting fate and transport modeling as discussed in other Solid Waste Guidelines.

3.0 Model Use

The HELP Model was developed in order to provide landfill designers and permit evaluators with a simple tool for evaluating the performance of alternative landfill designs. A secondary goal of the model's development was the accurate prediction of water budget components (EPA/625/4-91/025, May 1991). Recent evaluations of actual leachate generation rates have shown that the HELP model can also be a very good approximation to actual conditions (M.A. Othman et al., 1998), although at least one researcher has indicated that HELP may over-predict leachate generation in arid environments (Kowalewski,P.J., 1999).

The model uses water balance computations to simulate the storage and vertical migration of leachate through a landfill design. The model is most useful when the weather data is kept relatively constant and the facility design is varied. By using this approach, the performance of various designs can be evaluated with respect to each other. The model is capable of simulating leachate movement through the landfill while it is open (active) as well as closed (after placement of the final cover). The HELP model requires the user to define three sets of data: weather data, soil data and design data.

3.1 Weather data

The weather data in HELP in classified into four groups: evapotranspiration, precipitation, temperature, solar radiation.

The Department has files available which contain 20 years of daily precipitation data for 53 different locations throughout Wyoming. The model also contains coefficients for generating synthetic weather data for the same locations. In addition, long-term monthly rainfall averages can be obtained from the National Weather Service and entered into the model. The Department recommends either using the default rainfall and temperature data or utilizing the long-term data from the weather service, and letting the model generate the other necessary weather data (and solar radiation). Once the weather data set is defined, the model will automatically use it for each of the performance simulation runs, unless the data set is edited.

The only other weather related information that needs to be specified is the "Evaporative Zone Depth" (EZD). The EZD represents the maximum depth from which water can be removed through evapotranspiration. Therefore, the EZD is typically equal to the root depth of the vegetative cover, which should never penetrate the uppermost soil barrier layer. In fact, the model will not allow the EZD to penetrate the uppermost soil barrier layer. If the vegetative cover of the landfill design is changed the EZD needs to be re-evaluated and modified if necessary.

Information about the effective root depths for various species of plants should be obtained from the seed suppliers. Also, information regarding native plant species is available from the Bureau of Land Management (BLM).

3.2 Soil Data

The HELP model contains 42 default soil, waste, and geosynthetic layers that may be used for modeling, (refer to Table 4. in the HELP Users Manual) with data for porosity, field capacity, wilting point, and saturated hydraulic conductivity. The default characteristics of types 1 through 15 are typical of surficial and disturbed agricultural soils, which may be less consolidated and more aerated than soils typically placed in landfills (EPA/600/R-94/168a). Soil types 16 and 17 represent very well compacted clay materials that might typically be used for barrier soil liners. Soil types 18 and 19 represent compacted municipal solid waste; type 19 represents waste with channeling and dead zones. Soil types 22 through 29 represent moderately compacted soils. Soil types 30 through 33 represent specific types of ash/slag, while 34 through

42 represent different types of geosynthetic materials. Research and anecdotal information on the subject of flow through waste indicates that leachate flows through a relatively limited portion of the available flow area, therefore, soil/material classification #19 (Municipal Waste with channeling and dead zones) needs to be assigned to all waste layers (Zeiss and Major, 1992-93, and Uguccioni, M., Zeiss, C., 1996). Application of the default soil properties is generally appropriate only for planning level studies and are not intended to replace design level laboratory and field testing programs (EPA/600R-64/168b, page 17-18).

Material descriptions can be selected from the default list; however, site specific characteristics and material properties are recommended since properties within a soil classification can vary substantially (EPA/625/4-91/025). When site specific soil/material characteristics are utilized, the porosity, field capacity, wilting point, and saturated hydraulic conductivity of each layer must be documented.

3.3 Design Data

The HELP model allows four (4) different "types" of layers in the construction of the landfill design.

"Type 1"	Vertical Percolation Layer - materials with hydraulic conductivities greater than 1×10^{-6} cm/sec (e.g., top soil, routine cover, municipal waste, etc..)
"Type 2"	Lateral Drainage Layer - promote lateral drainage and have hydraulic conductivities greater than 1×10^{-3}cm/sec (e.g., lateral drainage from cover, leachate collection)
"Type 3"	Barrier Soil Liner - compacted soil with hydraulic conductivities typically less than 1×10^{-6} cm/sec (e.g., clay barrier layers below liners, clay barrier layer in caps)
"Type 4"	Geomembrane Liner - synthetic membrane liner (e.g., PVC, HDPE, etc.)

> **Note:** *Soils used as routine or intermediate cover must be classified as vertical percolation layers unless documentation shows they have saturated hydraulic conductivities less than 1×10^{-6} cm/sec (EPA/600/R-94/168b).*

The basic rules regarding the arrangement of layers in the landfill design, as discussed on page 28 of the HELP Model User's Guide Version 3 (September 1994), must be followed. In addition, the landfill design in HELP must be constructed identical to the design(s) being evaluated

The following design and site information is also needed to properly construct the model:

1. SCS Runoff Curve Number (default values available)
2. Landfill surface area (square feet), slopes (%), and slope lengths.
3. Initial soil water content (model will initialize if not known or specified)
4. Vegetative Cover Type: 1 for bare ground, 2 for poor grass, 3 for fair grass, 4 for good grass, 5 for excellent grass. Site specific justification is required for

vegetative cover numbers greater than 2. (NOTE: poor to fair grass is about the best level that is attainable in Wyoming)

5. Maximum Leaf Area Index: 0.0 for bare ground, 1.0 for poor grass, 2.0 for fair grass, 3.3 for good grass, 5.0 for excellent grass. Site specific justification is needed for maximum leaf area index numbers greater than 2.

When running the HELP model, the Department has determined that the model simulation period must be for the active life of the landfill plus the 30 year post closure period at a minimum. In addition, the simulation period needs to include conditions at near steady state. For purposes of evaluating the sensitivity of time as it relates to leachate generation, the model should be run for 100 years if the active life plus 30 years is less than 100 years. The 100 year model run information will provide a long term average leachate generation rate. The HELP model is limited to 100 years of simulation for a single run. Therefore, if a facility simulation period exceeds 100 years the output data for the first 100 years will need to be utilized as the input data for succeeding runs.

4.0 Evaluating HELP model output data

The HELP model allows the user to specify the units of the HELP model output (customary or metric), the length of the simulation (1-100 years), and the output frequency (daily, monthly or annual). The Department recommends that customary units be utilized and the length of simulation be equal to the active life of the facility plus 30 years (the minimum post closure period) or until steady state conditions are reached.

Also, paper copies of the annual data and electronic copies of all other data must be submitted to the Department for review. All electronic data must also be submitted in "TEXT format -.txt".

5.0 Professional Geologist Certification

Geological services or work must be stamped, signed, and dated by a professional geologist (see W.S. § 33-41-115).

6.0 Additional Information

Further information or clarification can be obtained from the following Solid and Hazardous Waste Division offices. Comments and suggestions for improvements are always appreciated.

Casper:	(307) 473-3450
Cheyenne:	(307) 777-7752
Lander:	(307) 332-6924

7.0 References

Kowalewski, P.E., Comparative reclamation soil cover modeling in an arid environment, Tailings and Mine Waste' 9, 1999 Balkema, Rotterdam, ISBN 90 5809025 6.

Othman, , M.A., Bonaparte, R., Gross, B.A., and Warren, D., 1998, Evaluation of Liquids Management Data for Double Lined Landfills, Draft Document prepared for U.S. Environmental Protection Agency, National Risk Management Laboratory, Cincinnati, OH; as cited in: Richardson, G., April 2001, Design of Waste Containment and Final Closure Systems (Course Notes), American Society of Civil Engineers Seminar, Denver, CO.

Zeiss, Chris, and Major, Wade., Moisture Flow Through Municipal Solid Waste: Patterns and Characteristics, J. Environmental Systems, Vol. 22(3) 211-231, 1992-93.

Uguccioni, M., Zeiss, C., 1996, Comparison of two approaches to modeling moisture movement through municipal solid waste, Journal of Environmental Systems, v. 25, no. 1, p. 41-63.

U.S. EPA, September 1994a, The Hydrologic Evaluation of Landfill Performance (HELP) Model User's Guide for Version 3, EPA/600R-64/168a.

U.S. EPA, September 1994b, The Hydrologic Evaluation of Landfill Performance (HELP) Model Engineering Documentation for Version 3, EPA/600R-64/168b.

U.S. EPA, May 1991, Design and Construction of RCRA/CERCLA Final Covers, EPA/625/4-91/025.

8.0 Guideline Approval

I have reviewed and approved the policies and procedures described in this guidance document.

Signed

C Anderson 7/16/09

Carl Anderson, Ph.D.
Administrator
Solid and Hazardous Waste Division
Department of Environmental Quality

Date

Guideline History

August 22, 2002:	Work Group Draft Version 1 - DO NOT CITE
August 22, 2003:	Work Group Draft Version 2 - DO NOT CITE
December 17, 2003:	Work Group Draft Version 3 - DO NOT CITE
June 23, 2009:	Final Version