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SMALL LANDFILLS IN KANSAS: MINIMUM REQUIREMENTS FOR PROTECTING THE PUBLIC HEALTH AND ENVIRONMENT

By

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Disclaimer

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According to State of Kansas Solid Waste Regulations, small municipal landfills may be exempted from the design requirements in K.A.R. 28-29-104 (requiring phase I and phase II hydrogeologic site investigations, liner and leachate collection systems and monitoring) provided the following demonstrations can be made.

1. The landfill receives and disposes less than 20 tons of municipal solid waste daily, based on an annual average.

2. The landfill is located in an area that receives less than or equal to 25 inches of precipitation on an annual average.

3. There is no evidence of groundwater contamination from the landfill, and

4. There is no practicable waste management alternative.

Most of western Kansas municipal landfills fall into the category of small landfills. The questions often posed are what should be the minimum requirements for small landfills for protecting the public health and environment, and what the risks are for doing nothing, i.e., imposing no regulations for small landfills. This report provides some technical guidance, based on HELP landfill simulations, towards addressing these concerns.

To address the posed questions, a representative or typical western Kansas small landfill needs to be identified. After briefly examining the available information on landfills in Cheyenne, Greely, Rawlins, and Wallace counties, we tentatively concluded that the Wallace County landfill, being a representative western Kansas small landfill, had the more detailed and probably reliable information for answering the posed questions. Table 1 profiles the Wallace county landfill.

The tool we employed to evaluate a number of conceptual small landfill scenarios based on the Wallace County landfill is the well known HELP model. The base case landfill scenario consists of a 500 ft by 80 ft waste cell which is 25 ft deep and is underlain by a water table at 45 ft below land surface. Temperature and precipitation data (1951-1976) from nearby Sharon Springs, and other climatic data from Dodge City, Kansas are considered representative for the study region.

We evaluated, using the HELP model, the significance of having a landfill cover versus no cover (see Table 2), having a liner versus no liner, having a leachate collection system versus no such system, and any combination of these options. We also evaluated two different slopes (2% and 4%) and two different slope lengths (500 ft and 250 ft) for the leachate collection system, and two soil composition sets (initial and modified, Table 3). Table 4 details some HELP case runs employed in this study. Figure 1 displays the annual precipitation and air temperature for a twenty-year simulation period employed in this study.

It is worth noting two non-standard extensions of the HELP model we employed in this study. (1) Instead of simply calculating the leachate produced at the bottom of the landfill liner, we calculated the leachate quantities at the water table by inserting a vertical percolation layer, representing the natural soil material, between the landfill bottom and the water table. (Later on we plan to employ the MULTIMED model to evaluate the attenuating impact of this vadose zone.) (2) The HELP model does not allow including a leachate collection system without having a liner underneath this system. Because KDH&E was also interested in evaluating the impact of a leachate collection system by itself, without the presence of an underlying liner, we "tricked" the HELP model in simulating such a case by inserting a "pseudo-liner" under the leachate collection system of the same composition and physical properties as the rest of the underlying naturally existing vertical percolation layer.

The results of all these HELP simulation scenarios are summarized in Tables 5 through 7. The worst case scenario (no cover, no liner, no leachate collection system) results in a landfill leachate percolation rate to the water table equal to approximately 10% of the average annual precipitation. As shown in these tables, any combination of landfill cover, liner and leachate collection system will significantly reduce this leachate percolation rate. The results show that landfill cover is extremely important in reducing leachate percolation to the water table (Table 5). Landfill liner is most important when no leachate collection system is in place (Table 6); it becomes less important when a cover and leachate collection system is present (it decreases leachate percolation to the water table by an additional 3-7%). The landfill leachate collection system becomes most important when no liner is present in a landfill with cover (Table 7). When a liner is present in a covered landfill, the leachate collection system becomes less important (it decreases leachate percolation to the water table by an additional 7-10%). All summary tables (5 through 7) quantify the impact of any cover-liner-leachate collection system combination on leachate percolation to the water table. Table 8 ranks the relative importance of these scenarios with respect to their efficiency in reducing leachate percolation to the underlying aquifer.

Table 1

Wallace County Landfill Profile

(Adapted from AGD Services, Inc. reports)

Location: Forty four acres located in the SE 1/4 of Section 3, and the NE 1/4 of Section 10, both located in Township 14 South, Range 40 West, two miles south of Sharon Springs, Kansas.

Operation Authorization: 1974

Topography: The active portion of the landfill is situated along the north side of a northeasterly running intermittent stream channel. Side slopes are up to twenty percent at the east end of the property.

Site History and Operation: Trenches have been dug and filled on the west-central portion of the landfill property, all on the north side of the draw. Expansion room is left to the north and east.

Geology and Soils: The local geology consists of soils of the Colby-Kim-Midway Association (silty loam to silty clay loam) underlain by Pleistocene Loess of the Sanborn Formation. These formations are underlain by the Miocene Ogallala Formation. The Ogallala is an unconfined aquifer and is the primary groundwater aquifer in the region. Bedrock is the Cretaceous Pierre Shale.

Groundwater and Monitoring: Groundwater availability in this area is limited. Three monitoring wells ranging in depth from 50 to 58 ft were installed at the landfill in 1993. The static water level was 41 to 46 ft. One well was dry. Water analysis from the wells indicate no adverse impact on the groundwater has occurred at this landfill.

Table 2.
Wallace County Landfill - HELP simulation data

	No Cover	Cover
Evaporative Zone Depth	12 in.	18 in.
Max. Leaf Area Index	0	2
Percent of Area Where Runoff is Possible	0%	80%
Runoff Curve Number	70	80

Weather Station - Dodge City, Kansas; Sharon Springs, Kansas

Growing Season Start Day - Default (Julian Day 102)

Growing Season End Day - Default (Julian Day 298)

Average Wind Speed - Default (13.9 mph)

Quarterly Relative Humidities - Default (64%, 59%, 57%, 62%)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Precipitation -	0.40	0.43	1.17	1.27	2.90	3.17	2.84	1.85	1.68	1.04	0.75	0.45
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature -	31.9	35.9	41.4	52.9	63.3	73.6	79.0	77.1	67.3	56.1	41.6	33.5

Temperature and precipitation recorded at Sharon Springs, KS for the period 1951-1976

Average Annual Precipitation - 17.38 in.

Area of Individual Waste Cell - 0.92 acres

Total Area of Expansion - 12 acres

Slope of Lateral Drainage Layers - 2% or 4%

Slope Length of Lateral Drainage Layers - 250 ft or 500 ft

Depth to Groundwater - 45 ft

Simulation period - 20 years

Table 3

Soil and Waste HELP Simulation Data

Initial Soil Set -	Cover = SiCL (HELP #12) Waste = (HELP #18) Leachate Collection System = S (HELP #2) Barrier Layer = SiCL (HELP #12) Natural Soil = SiL (HELP #9)
Modified Soil Set -	Cover = SiCL (HELP #12) Waste = (HELP #18) Leachate Collection System = Gravel (HELP #21) Barrier Layer = Compacted SiCL (HELP #26) Natural Soil = SiCL (HELP #12)

Figure 1

Annual Precip. and Air Temperature
Wallace County Landfill

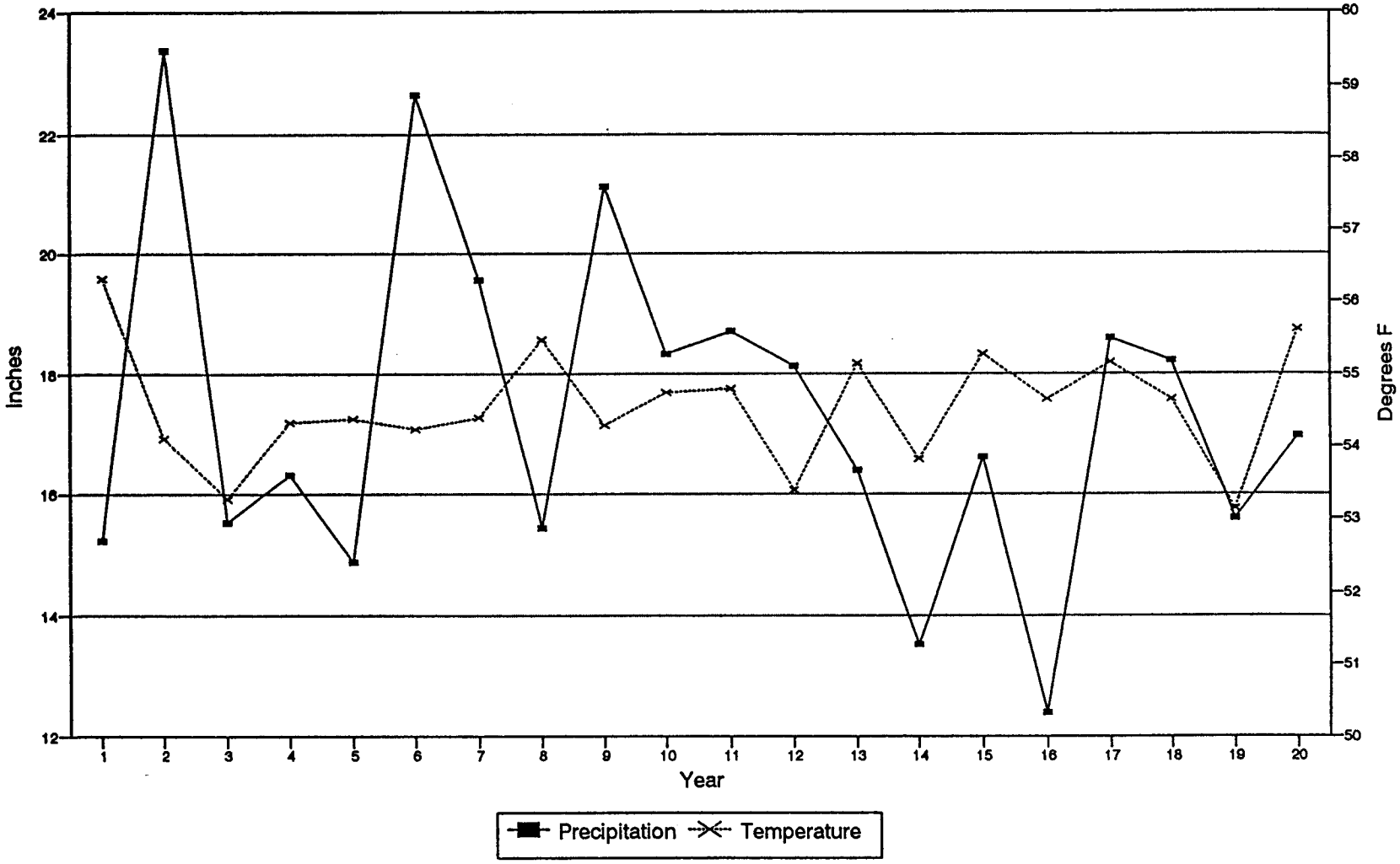
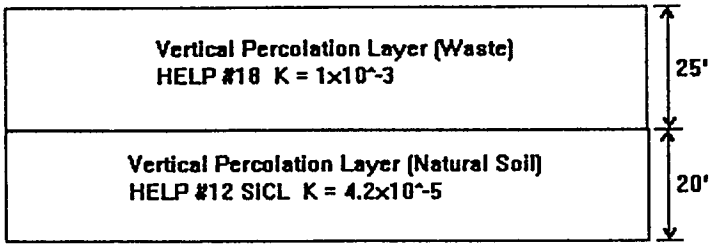


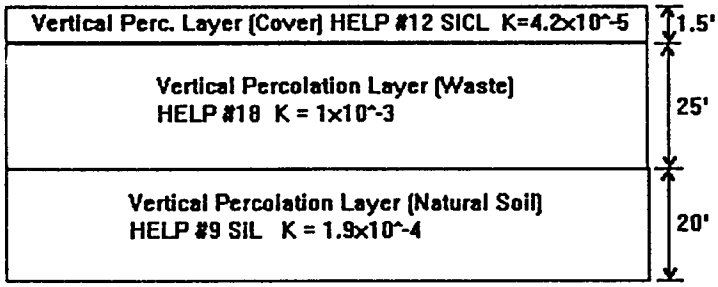
Table 4: Selected HELP Simulation Scenarios

Case #1 - Individual Cell: No Cover, No Leachate Collection, No Liner



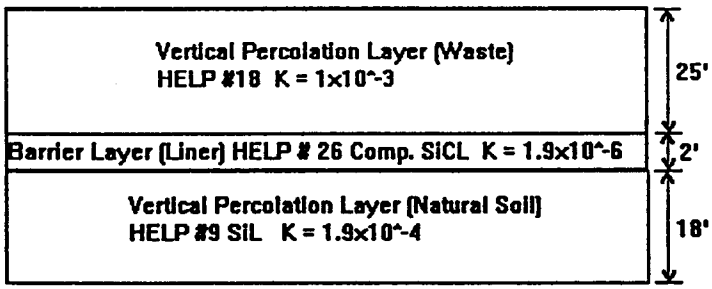
Evaporative Zone Depth = 12 in.
Maximum Leaf Area Index = 0
Area = 0.92 acres
Percent Area Where Runoff is Possible = 70%
Initial Soil Moisture = Field Capacity
Runoff Curve Number = 70

Case #2 - Individual Cell: 1.5' Cover, No Leachate Collection, No Liner



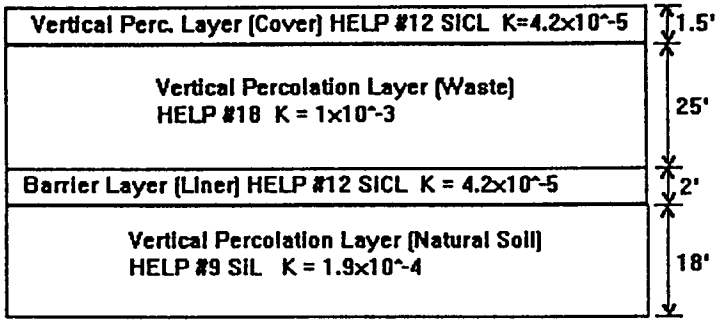
Evaporative Zone Depth = 18 in.
Maximum Leaf Area Index = 2
Area = 0.92 acres
Percent Area Where Runoff is Possible = 80%
Initial Soil Moisture = Field Capacity
Runoff Curve Number = 80

Case #3 - Individual Cell: No Cover, No Leachate Collection, 2' Liner



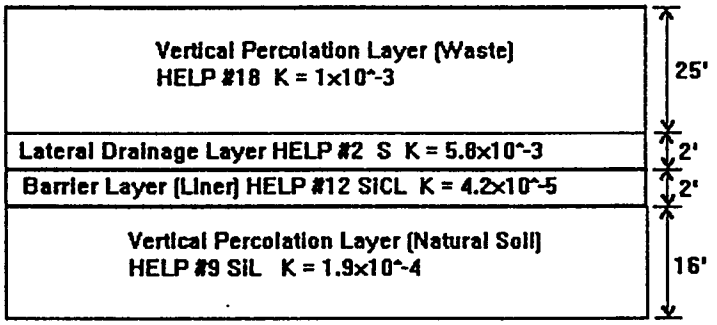
Evaporative Zone Depth = 12 in.
Maximum Leaf Area Index = 0
Area = 0.92 acres
Percent Area Where Runoff is Possible = 70%
Initial Soil Moisture = Field Capacity
Runoff Curve Number = 70

Case #4 - Individual Cell: 1.5' Cover, No Leachate Collection, 2' Liner



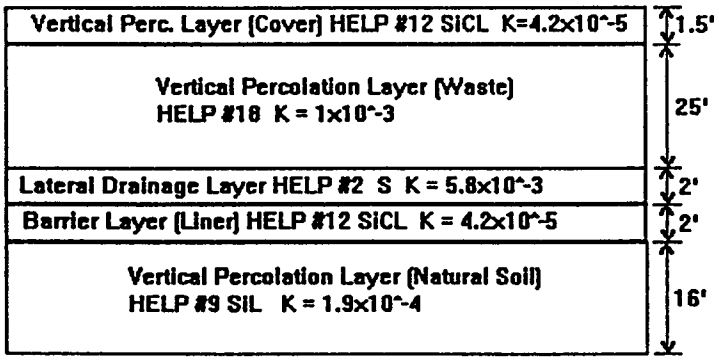
Evaporative Zone Depth = 18 in.
Maximum Leaf Area Index = 2
Area = 0.92 acres
Percent Area Where Runoff is Possible = 80%
Initial Soil Moisture = Field Capacity
Runoff Curve Number = 80

Case #5 - Individual Cell: No Cover, 2' Leachate Collection, 2' Liner



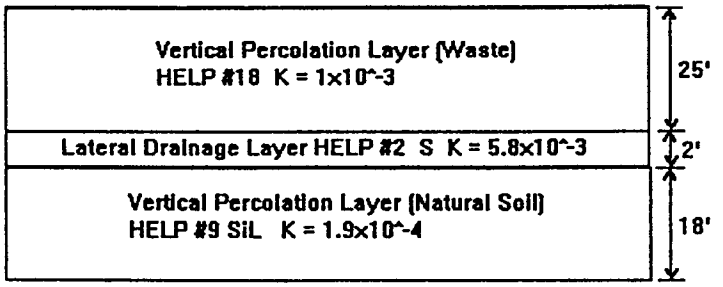
Evaporative Zone Depth = 12 in.
Maximum Leaf Area Index = 0
Area = 0.92 acres
Percent Area Where Runoff is Possible = 70%
Initial Soil Moisture = Field Capacity
Runoff Curve Number = 70

Case #6 - Individual Cell: 1.5' Cover, 2' Leachate Collection, 2' Liner



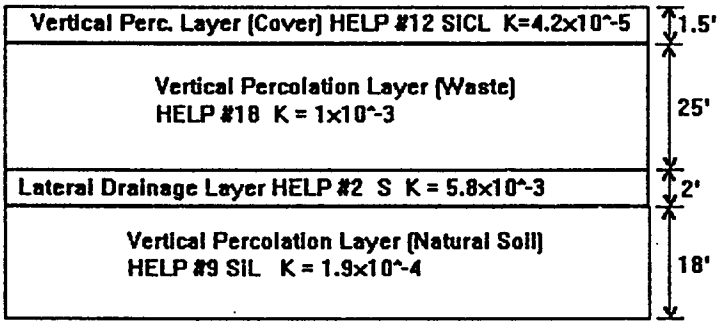
Evaporative Zone Depth = 18 in.
Maximum Leaf Area Index = 2
Area = 0.92 acres
Percent Area Where Runoff is Possible = 80%
Initial Soil Moisture = Field Capacity
Runoff Curve Number = 80

Case #9 - Individual Cell: No Cover, 2' Leachate Collection, No Liner



Evaporative Zone Depth = 12 in.
Maximum Leaf Area Index = 0
Area = 0.92
Percent Area Where Runoff is Possible = 70%
Initial Soil Moisture = Field Capacity
Runoff Curve Number = 70

Case #10 - Individual Cell: 1.5' Cover, 2' Leachate Collection, No Liner



Evaporative Zone Depth = 18 in.
Maximum Leaf Area Index = 2
Area = 0.92
Percent Area Where Runoff is Possible = 80%
Initial Soil Moisture = Field Capacity
Runoff Curve Number = 80

Table 5. Wallace County Landfill - Comparison of No Cover versus Cover Scenarios

			Leachate Collection			Leachate	Leachate	Percent
CASE #	Leachate Collection	Liner	Slope Length (ft)	Slope Percent	Soil Set	Production No Cover (in)	Production With Cover (in)	Leachate Decrease *
35 / 36	Y	Y	250	4	MODIFIED	1.234	0.682	44.73
15 / 16	Y	Y	250	2	MODIFIED	1.266	0.691	45.42
33 / 34	Y	Y	500	4	MODIFIED	1.267	0.692	45.38
13 / 14	Y	Y	500	2	MODIFIED	1.296	0.700	45.99
39 / 40	Y	N	250	4	MODIFIED	1.389	0.719	48.24
19 / 20	Y	N	500	4	MODIFIED	1.392	0.720	48.28
37 / 38	Y	N	250	2	MODIFIED	1.392	0.720	48.28
17 / 18	Y	N	500	2	MODIFIED	1.394	0.721	48.28
23 / 24	N	Y	NA	NA	MODIFIED	1.414	0.758	46.39
5 / 6	Y	Y	500	2	INITIAL	1.424	0.780	45.22
7 / 8	Y	Y	250	2	INITIAL	1.424	0.780	45.22
9 / 10	Y	N	500	2	INITIAL	1.424	0.780	45.22
11 / 12	Y	N	250	2	INITIAL	1.424	0.780	45.22
25 / 26	Y	Y	500	4	INITIAL	1.424	0.780	45.22
27 / 28	Y	Y	250	4	INITIAL	1.424	0.780	45.22
29 / 30	Y	N	500	4	INITIAL	1.424	0.780	45.22
31 / 32	Y	N	250	4	INITIAL	1.424	0.780	45.22
3 / 4	N	Y	NA	NA	INITIAL	1.470	0.840	42.86
21 / 22	N	N	NA	NA	MODIFIED	1.559	1.205	22.71
1 / 2	N	N	NA	NA	INITIAL	1.700	1.330	21.76

* When cover is installed

Table 6. Wallace County Landfill - Comparison of No Liner versus Liner Scenarios

			Leachate Collection			Leachate Production	Leachate Production	Percent Leachate
CASE #	Cover	Leachate Collection	Slope Length (ft)	Slope Percent	Soil Set	**No Liner (in)**	**With Liner (in)**	Decrease*
40 / 36	Y	Y	250	4	MODIFIED	0.719	0.682	5.15
20 / 16	Y	Y	250	2	MODIFIED	0.720	0.691	4.03
38 / 34	Y	Y	500	4	MODIFIED	0.720	0.692	3.89
18 / 14	Y	Y	500	2	MODIFIED	0.721	0.700	2.91
10 / 6	Y	Y	500	2	INITIAL	0.779	0.779	0.00
12 / 8	Y	Y	250	2	INITIAL	0.779	0.779	0.00
30 / 26	Y	Y	500	4	INITIAL	0.779	0.779	0.00
32 / 28	Y	Y	250	4	INITIAL	0.779	0.779	0.00
22 / 24	Y	N	NA	NA	MODIFIED	1.205	0.758	37.10
2 / 4	Y	N	NA	NA	INITIAL	1.330	0.840	36.84
39 / 35	N	Y	250	4	MODIFIED	1.389	1.234	11.16
19 / 15	N	Y	250	2	MODIFIED	1.392	1.266	9.05
37 / 33	N	Y	500	4	MODIFIED	1.392	1.267	8.98
17 / 13	N	Y	500	2	MODIFIED	1.394	1.296	7.03
9 / 5	N	Y	500	2	INITIAL	1.424	1.424	0.00
11 / 7	N	Y	250	2	INITIAL	1.424	1.424	0.00
29 / 25	N	Y	500	4	INITIAL	1.424	1.424	0.00
31 / 27	N	Y	250	4	INITIAL	1.424	1.424	0.00
21 / 23	N	N	NA	NA	MODIFIED	1.559	1.414	9.30
1 / 3	N	N	NA	NA	INITIAL	1.700	1.470	13.53

* When liner is installed

Table 7. Wallace County Landfill - Comparison of No Leachate Collection versus Leachate Collection Scenarios

					Leachate Production with Leachate Collection System							
					Slope Length = 500'				Slope Length = 250'			
			Soil	Leachate Production with	2% Slope		4% Slope		2% Slope		4% Slope	
CASE #	Cover	Liner	Set	NO Leach. Coll. (in)	Leachate (in)	% Decrease*	Leachate (in)	% Decrease*	Leachate (in)	% Decrease*	Leachate (in)	% Decrease*
1	N	N	Initial	1.704	1.424	16.43	1.424	16.43	1.424	16.43	1.424	16.43
2	Y	N	Initial	1.332	0.779	41.52	0.779	41.52	0.779	41.52	0.779	41.52
3	N	Y	Initial	1.473	1.420	3.60	1.424	3.33	1.424	3.33	1.424	3.33
4	Y	Y	Initial	0.840	0.780	7.14	0.779	7.26	0.779	7.26	0.779	7.26
21	N	N	Modified	1.559	1.394	10.58	1.392	10.71	1.392	10.71	1.389	10.90
22	Y	N	Modified	1.205	0.721	40.17	0.720	40.25	0.720	40.25	0.719	40.33
23	N	Y	Modified	1.414	1.296	8.35	1.267	10.40	1.266	10.47	1.234	12.73
24	Y	Y	Modified	0.758	0.700	7.65	0.692	8.71	0.691	8.84	0.682	10.03

* Relative to no leachate collection system.

Table 8

Western Kansas Small Landfill Simulation Conclusions

Order of Importance	Leachate Reduction
1. Cover	45% compared to no cover
2. Cover and Leachate Collection w/ no Liner	41% compared to no leachate collection
3. Cover and Liner w/ no Leachate Collection	37% compared to no liner
4. Cover and Liner w/ Leachate Collection	An additional 7-10% compared to no leachate collection (3)
5. Cover and Liner w/ Leachate Collection	An additional 3-7% compared to no liner (2)