| | | |
|---|---|---|
| Percent Sand | 19.00 | 29.00 |
| Percent Silt | 42.00 | 29.00 |
| Percent Clay | 30.00 | 24.00 |
| Percent Sand, Excluding Gravel* | 20.90 | 35.40 |
| Percent Silt, Excluding Gravel* | 46.20 | 35.40 |
| Percent Clay, Excluding Gravel* | 33.00 | 29.30 |
| USDA Classification | Clay Loam | Clay Loam |
| Hydraulic Conductivity as determined on remolded samples ** | 7.1 X $10^{-4}$ cm/second (compacted to 95% of maximum dry density) | 2.9 X $10^{-5}$ cm/second (compacted to 96.3% of maximum dry density) |

** In the USDA system of textural classification soil texture is determined using only the weight proportion of soil particles less than 2 mm in diameter as determined from laboratory particle-size distribution analyses (gradation). Coarser particles are considered "rock fragments," and are not utilized for "fine earth" soil classification.*

*** Analyses of hydraulic conductivity for samples compacted to 95% of maximum dry density ranged from 3.0 X $10^{-4}$ to 7.1 X $10^{-4}$ cm/second.*

Fine-grained soils from five feet below ground level (BGL) along with gravelly sand soils recovered from depths of 10 feet and 20 feet BGL were combined in Bingham's Composite Sample No. 1 and tested for permeability. These combined soils had the slowest infiltration rates of Bingham's four permeability tests. Three other permeability tests were conducted on coarser materials from 25 feet BGL or deeper.

**14.4 Soil Properties Determined by Tri-State Testing Laboratories, Inc.**

Additional soil samples were recovered from an open trench at the northern edge of the existing landfill prism. The trench was about 28 feet deep. Soils in the first ten feet below ground level are mostly silt and clay, with only traces of gravel. Below 10 feet silty, clayey, sand and gravel are predominant. All soils are tan and dry down to about 25 feet. Soils below

25 feet are moist and orange-brown in color, suggesting oxidation from fluctuating levels of ground water.

Channel samples were collected from a ten-foot thick layer of sandy clay (CL) present from ground level to 10 feet below ground. Soil properties (gradation, PI, plastic limit, MDD and OMC) were obtained for three clay samples. These values were determined by Tri-State Testing Laboratories, Inc.

The specified soil properties of final cover materials are described below:

**CHARACTERIZATION TEST RESULTS OF FINAL COVER MATERIALS**

| SAMPLE | GRAVEL % | SAND % | SILT AND CLAY % | MDD (pcf) | [illegible] | LL | PI | USCS NAME |
|---|---|---|---|---|---|---|---|---|
| "S" | 2.2 | 31.5 | 66.3 | 100.5 | 20.5 | 34 | 13 | CL |
| "D" | 10.6 | 33.9 | 55.5 | 102 | 20.5 | 35 | 15 | CL |
| Composite | 6.4* | 32.7* | 60.9* | 101.2 | 20.5 | 34.5* | 14* | CL |

* *Values with an asterisk are mathematical averages of values for samples "S" and "D." Values without asterisks are results from physical measurements.*

Constant head permeability values for the samples analyzed by Tri-State were obtained by IGES consultants of Salt Lake City, Utah. All tests were run at 5 psi back pressure.

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**PERMEABILITY TEST RESULTS OF INFILTRATION LAYER COVER MATERIALS**

| SAMPLE NUMBER | PERMEABILITY | SAMPLE PREPARATION |
|---|---|---|
| "S" | 2.26 X 10^-5 | 90% MDD |
| "S" | 3.29 X 10^-7 | 95% MDD |
| "D" | 3.26 X 10^-5 | 90%MDD |
| "D" | 1.72 X 10^-7 | 95% MDD |
| PHYSICAL MIXTURE OF "S" AND "D" | 8.32 x 10^-6 | 93% MDD |

# 15 HELP3 MODEL INPUT AND RESULTS

Each HELP3 output file included with this CPA contains summaries of the input parameters. The following discussion may be beneficial to reviewers and potential interveners unfamiliar with the HELP3 computer model. The following overview of the HELP3 input values is copied from Section 3.1 of the engineering documentation.

> "The HELP model requires general climate data for computing potential evapotranspiration; daily climatologic data; soil characteristics; and design specifications to perform the analysis. The required general climate data include growing season, average annual wind speed, average quarterly relative humidities, normal mean monthly temperatures, maximum leaf area index, evaporative zone depth and latitude. Default values for these parameters were compiled or developed from the "Climates of the States" (Ruffner, 1985) and "Climatic Atlas of the United States" (National Oceanic and Atmospheric Administration, 1974) for 183 U.S. cities. Daily climatologic (weather) data requirements include precipitation, mean temperature and total global solar radiation. Daily rainfall data may be input by the user, generated stochastically, or taken from the model's historical data base. The model contains parameters for generating synthetic precipitation for 139 U.S. cities. The historical data base contains five years of daily precipitation data for 102 U.S. cities. Daily

temperature and solar radiation data are generated stochastically or may be input by the user."

"Necessary soil data include porosity, field capacity, wilting point, saturated hydraulic conductivity, initial moisture storage, and Soil Conservation Service (SCS) runoff curve number for antecedent moisture condition II. The model contains default soil characteristics for 42 material types for use when measurements or site-specific estimates are not available. The porosity, field capacity, wilting point and saturated hydraulic conductivity are used to estimate the soil water evaporation coefficient and Brooks-Corey soil moisture retention parameters. Design specifications include such items as the slope and maximum drainage distance for lateral drainage layers: layer thicknesses; layer description; area; leachate recirculating procedure; subsurface inflows; surface characteristics; and geomembrane characteristics."

Each input parameter for the Chester Class II Landfill CPA modeling was selected from default values included in the program, or manually chosen and entered by Utah Professional Geologist Gary F. Player. Player has approximately ten years of experience preparing accepted HELP3 models for landfills in Utah, Nevada, and Idaho. The following discussion provides the rationale for his choices.

**15.1 Climate Data**

The climate data was generated stochastically, using historical data for Ephraim's Sorensen's Field weather station–the closest data set. Synthetic precipitation, temperature, and solar radiation tables were generated by the HELP3 program for sixty years of average climate with predicted fluctuations from the mean.

Rainfall, daily snow depth, and temperature data for Sorensen's Field were obtained from the Western Regional Climate Center of the Desert Research Institute, Las Vegas, Nevada. The period of record for precipitation was from 1949 to early 2003. The period of record for daily snow depth was from September 1949, to the end of 2001. The period of record for temperature was from 1950 to January of 2003.

Statistical parameters for Salt Lake City were used for the generation of synthetic climate data for Sorensen's Field. Salt Lake City was chosen, as it is the closest city with statistical climatological data incorporated in the HELP3 program. The climate at Salt Lake City is somewhat different from that of Sanpete County. However, the differences cancel each other out: Salt Lake City is slightly warmer with a longer growing season, while the humidity is higher than Sanpete County (reducing evaporation potential) due to the lake effect of Great Salt Lake. The cumulative effect of differences in evaporation and transpiration is slight.

Initially errors occurred when climate data for wettest and driest years were modeled for one year only. The stochastically generated annual precipitation differed from the total of the manually entered monthly values. This program-induced error was overcome by modeling each "wettest" and "driest" year for sixty years, and then extracting the data for one year that most closely matched the actual, measured, climate data. The extracted data was then entered manually as user specified daily precipitation values for the wettest and driest years.

### 15.2 HELP3 Soil Data

Soil information used in the Chester Class II HELP3 models was compiled from:

(1) site specific laboratory analyses; and
(2) published values for thousands of similar soils summarized in technical publications.

#### 15.2.1 Site Specific Laboratory Analyses

Two sets of laboratory analyses were provided in the *Closure Plan - Sanpete Class II Landfill* which was delivered to you on April 14, 2003. The first set was prepared from test borings completed by Bingham Engineers in 1995. The second set consisted of bulk samples collected from trenches logged by Gary F. Player in 2000. This set was analyzed by Tri-State Laboratories and IGES, Inc. Summaries of these analyses are presented in Sections 14.3 and 14.4 (above).

Four additional bulk samples were collected by Player in April and May of 2003. These were analyzed by GEO Consultants of Cedar City, Utah, under the direction of Joel A. Myers, P.E. Two of the samples were of intermediate cover in place on the northern and southern ends of the landfill prism. The remaining two samples were taken from the first five feet of soils exposed in a trench north of the landfill prism. Copies of these four analyses were included as an Appendix to the Revised Response to the Request for Additional Information dated June 16, 2004. The GEO Consultants data are summarized in the following Table:

| Sample | Sand Percent | Silt Percent | Clay Percent | USCS Name | USDA Classification |
|---|---|---|---|---|---|
| Intermediate Cover, S. End | 34 | 40.2 | 25.8 | CL-ML | Loam |
| Intermediate Cover, N. End | 36.2 | 13 | 50.7 | CL | Clay |
| Chester 1 (Trench) | 30.7 | 48.5 | 20.8 | CL | Loam |
| Chester 2 (Trench) | 27 | 30 | 43 | CL | Clay (near Clay Loam) |

### 15.2.2 Published Values

Data for manually entered porosity, field capacity, wilting point and saturated hydraulic conductivity values were developed from a table prepared by Rawls and Brakensiek (1985). Their table contains moisture retention data for loam (383 samples), clay loam (366 samples), and clay (291 samples).

The Coop will construct the entire thickness of the closure cap without segregating the organic rich few inches of onsite soils. Sufficient organic and/or synthetic fertilizers will be applied as needed to encourage the growth of vegetation on the closure cap.

The so-called "bath tub effect" will not occur beneath the Closed Chester Class II Landfill. Section R315-303-3(4)(a)(i)(A) of the rules requires that the final cover, in no case, shall be more permeable than the bottom liner system or natural subsoils present beneath the landfill.

The proposed alternative closure cap will be constructed of loosely compacted clay loam and clay loam soils excavated from the landfill site. Numerous site specific physical measurements of saturated hydraulic conductivity are on hand for these soils when moderately compacted (as in the intermediate cover).

A test pad was constructed onsite using the specified cover soils in October of 2000. Minimal compactive effort using rubber tired vehicles provided compaction values ranging from 88 percent of maximum dry density (MDD), to 98.5 percent of MDD.

Test pad soils were collected from a surficial ten foot thick layer of sandy clay (CL) present just north of the landfill prism at the Class II Landfill site. Soil properties (gradation. PI, plastic limit, MDD and OMC) were obtained for three soil samples. These values were determined by Tri-State Testing Laboratories, Inc. The specified soil properties of infiltration layer materials are shown in Section 14.3 and 14.4, above.

The annual percolation of moisture through the materials proposed for use in the final cover are substantially less than permeability values measured by Bingham Engineers from samples collected at depths greater than 10 feet below ground level in their test borings. The Bingham values (at 95 percent MDD) range from 2.9 x 10^-5 to 3.0 x 10^-4 cm/sec, equivalent to **30 feet to 310 feet per year**. The modeled amount of average annual percolation through the proposed ET closure cap is only **.03825 inches per year** (see Section 20, below). Therefore, moisture percolating through the proposed closure cap will not accumulate at the base of the waste prism.

### 15.3 Plants

The selected seed mix will represent the local "climax" plant community. However, the mix will not be restricted to native plants. Nonnative plants may be selected that will enhance the vegetative cover. For example, drought resistant plants that transpire throughout the growing season would be preferable to native annual plants that become dormant in early summer.

Model simulations presented with this CPA have been run with an LAI of 1.6. That is the value for a poor stand of grass that the program provides for Salt Lake City, Utah. Use of "bare ground" dramatically increases modeled run-off, thereby decreasing the amount of annual precipitation that percolates through the landfill cover. The "poor stand of grass" is a more conservative LAI value.

## 16 FINAL COVER CONFIGURATION

Accurate modeling of landfill slopes is problematic. The shape of the landfill prism has varied and will always vary with time, due to (1) the application of waste, (2) grading before placement of the final cover. and (3) settlement of waste during the post-closure period.

Computer models presented with this CPA are based on the most conservative approach. Modeling of the proposed landfill closure cap incorporates the assumption of low. 5 percent slopes over the entire 12 acres of the landfill prism. Manually entered gentle slopes combined with the maximum slope distance of 1200 feet force the HELP3 program to calculate SCS runoff curve numbers that reduce runoff and maximize percolation rates through the surface layer of soils.

**16.1 Percent Gravel**

The amount of gravel in the soil that will be used in the alternative final cover cap is negligible. Material greater than 2 millimeters in diameter is considered "rock fragments," or gravel for the USDA soil classification. One shallow sample tested by Bingham Engineers contained 4.5 percent gravel greater than 2 millimeters in diameter.

Cover soils tested by GEO Consultants and Tri-State Testing utilized sieve size 4 as the cutoff for gravel, or 4.8 millimeters. This value, established by ASTM for USCS gradation curves, allows slightly coarser material to be classified as sand. The gravel in four GEO Consultant samples ranged from 1.4 to 5.2 percent. The gravel amounts in two Tri-State samples were 0.6 percent and 2.2 percent.

The most likely case for the percentage of gravel in soils to be utilized in the final cover is 5 percent larger than 2 millimeters in diameter. That amount would require the addition of 1.8 inches to a 36-inch thick ET cover. If the percentage of gravel were found to be10 percent, the extra cover thickness would be only 3.6 inches. The amount of soil needed to expand the cover for the occurrence of gravel will be determined during installation, when many additional samples for gradation will be collected.

**16.2 No Credit for Intermediate Cover**

All the soils analyses to date have shown that the intermediate cover now in place is identical in gradation and other soil properties to the materials present in the upper ten feet of soils exposed in trenches adjacent to the landfill prism. That is because the intermediate cover materials were excavated out of the shallow portions of the adjacent trenches.

The intermediate soils were placed and moderately compacted with rubber tired vehicles, as were the soils placed over the test pad referenced above. The compacted soils provide a good foundation for the final cover, but the moisture holding capacity and suitability as a substrate for plant growth is reduced by compaction. For those reasons, the intermediate cover will **not** be counted as part of the 36" thick closure cap.

# PART V--FINAL HELP3 COMPUTER MODELING

The Cooperative prepared dozens of computer models in an attempt to represent most accurately the performance of the proposed Chester ET closure cap.

Each model was prepared with the assumptions discussed above. The climate values and initial moisture content vary to reflect available data and antecedent modeling.

## 17 WET AND DRY CONDITIONS

Tables presented below include results of models of the Subtitle D prescribed cover using default soil type 11 for topsoil. Default soil type 25 was used for the 18 inches of barrier soil. The slope was reduced to 5 percent, with a slope distance of 1200 feet, and a poor stand of grass. This is a more conservative approach than using steeper slopes and shorter slope distances. Annual percolation through the base of layer two after 60 years of average climate was .04501 inches per year, or 0.38372 percent of annual precipitation.

Additional model simulations were performed to independently represent the five wettest and driest years. Two sets of models were run for both the recommended 36" evapotranspiration cover cap and a 24" thick Subtitle D cap. The first set of models ran for sixty years at average climates, followed by the five wettest years on record (from wettest to fifth wettest), followed by another sixty years at average climates. A second set of models for both closure cap types was run for sixty years at average climates, followed by the five driest years on record (from fifth driest to driest), followed by another sixty years at average climates.

### 17.1 Models Incorporating the Five Wettest Years

The following Table compares the results of 14 HELP3 model runs representing 60 years of average climate, followed by the five wettest years in descending order, and then another 60 years of average climate.

Revised, June 6, 2005

| Climate Model | Total Years | Landfill Model Name (.d10) | Output File Name (.out) | Start Layer(s) M.C. (%) | [illegible] | Average Annual Percolation (Inches) | Closure Cap Design |
|---|---|---|---|---|---|---|---|
| CHESTAVE | 60 | CH36NU60 | CHAVE60 | .187 | .2802 | 0.02293 | 36" ET |
| CHES1983 | 1 | CH36NU61 | CHESNU61 | .2802 | .3502 | 0.76160 | 36" ET |
| CHES1980 | 1 | CH36NU62 | CHESNU62 | .3502 | .3165 | 2.33192 | 36" ET |
| CHES1984 | 1 | CH36NU63 | CHESNU63 | .3165 | .2726 | 0.69701 | 36" ET |
| CHES1995 | 1 | CH36NU64 | CHESNU64 | .2726 | .2035 | 0.01279 | 36" ET |
| CHES1998 | 1 | CH36NU65 | CHESNU65 | .2035 | .2422 | 0.00001 | 36" ET |
| CHESTAVE | 60 | CH36N125 | CHSNU125 | .2422 | .2793 | 0.0275 | 36" ET |
| | | | | | | | |
| CHESTAVE | 60 | SUBDDS25 | SUBDDS25 | *1.* .187<br>*2.* .266 | *1.* .3323<br>*2.* .3292 | 0.04501 | SUBTITLE D, 24" |
| CHES1983 | 1 | SUBDNU61 | SUBDDS61 | *1.* .3323<br>*2.* .3292 | *1.* .2765<br>*2.* .4186 | 2.02997 | SUBTITLE D, 24" |
| CHES1980 | 1 | SUBDNU62 | SUBDDS62 | *1.* .2765<br>*2.* .4186 | *1.* .2507<br>*2.* .3682 | 2.71888 | SUBTITLE D, 24" |
| CHES1984 | 1 | SUBDNU63 | SUBDDS63 | *1.* .2507<br>*2.* .3682 | *1.* .4583<br>*2.* .3363 | 0.06708 | SUBTITLE D, 24" |
| CHES1995 | 1 | SUBDNU64 | SUBDDS64 | *1.* .4583<br>*2.* .3363 | *1.* .3082<br>*2.* .2692 | 1.667987 | SUBTITLE D, 24" |
| CHES1998 | 1 | SUBDNU65 | SUBDDS65 | *1.* .3082<br>*2.* .2692 | *1.* .3429<br>*2.* .3414 | 0.00148 | SUBTITLE D, 24" |
| CHESTAVE | 60 | SUBDN125 | SUBDN125 | *1.* .3429<br>*2.* .3414 | *1.* .3301<br>*2.* .3355 | 0.03669 | SUBTITLE D, 24" |

The following Table juxtaposes the modeling results for the 36" ET and Subtitle D covers, incorporating the five wettest years:

| Climate Model | Number of Years | Closure Cap Design | Average Annual Percolation (Inches) | [illegible] | Closure Cap Design |
|---|---|---|---|---|---|
| CHESTAVE | 60 | Subtitle D 24" | 0.04501 | 0.02293 | 36" ET |
| CHES1983 | 1 | Subtitle D 24" | 2.02997 | 0.76160 | 36" ET |
| CHES1980 | 1 | Subtitle D 24" | 2.71888 | 2.33192 | 36" ET |
| CHES1984 | 1 | Subtitle D 24" | 0.06708 | 0.69701 | 36" ET |
| CHES1995 | 1 | Subtitle D 24" | 1.667987 | 0.01279 | 36" ET |
| CHES1998 | 1 | Subtitle D 24" | 0.00148 | 0.00001 | 36" ET |
| CHESTAVE | 60 | Subtitle D 24" | 0.03669 | 0.0275 | 36" ET |

**17.2 Models Incorporating the Five Driest Years**

Another set of HELP3 models was then run using the five driest years in place of the five wettest years. In this case, the driest years were modeled from the fifth driest year to the driest year:

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| Climate Model | Years | Landfill Model Name (.d10) | Output File Name (.out) | Start Layer(s) M.C. (%) | [illegible] M.C. (%) | Average Annual Percolation (Inches) | Closure Cap Design |
|---|---|---|---|---|---|---|---|
| CHESTAVE | 60 | CH36NU60 | CHAVE60 | .187 | .2802 | 0.02293 | 36" ET |
| CHES1956 | 1 | CDRY3661 | CHDRY61 | .2802 | .2126 | 0.0145 | 36" ET |
| CHES1974 | 1 | CDRY3662 | CHDRY62 | .2126 | .2086 | 0.00004 | 36" ET |
| CHES1950 | 1 | CDRY3663 | CHDRY63 | .2086 | .2228 | 0.00002 | 36" ET |
| CHES1958 | 1 | CDRY3664 | CHDRY64 | .2228 | .2017 | 0.00009 | 36" ET |
| CHES1976 | 1 | CDRY3665 | CHDRY65 | .2017 | .1888 | 0.00001 | 36" ET |
| CHESTAVE | 60 | CDRY125 | CHDRY125 | .1888 | .2800 | 0.02240 | 36" ET |
| | | | | | | | |
| CHESTAVE | 60 | SUBDDS25 | SUBDDS25 | 1. .187<br>2. .266 | 1. .3323<br>2. .3292 | 0.04501 | SUBTITLE D, 24" |
| CHES1956 | 1 | SUBDRY61 | SUBDRY61 | 1. .3323<br>2. .3292 | 1. .3016<br>2. .2616 | 0.015116 | SUBTITLE D, 24" |
| CHES1974 | 1 | SUBDRY62 | SUBDRY62 | 1. .3016<br>2. .2616 | 1. .3285<br>2. .2798 | 0.00095 | SUBTITLE D, 24" |
| CHES1950 | 1 | SUBDRY63 | SUBDRY63 | 1. .3285<br>2. .2798 | 1. .2549<br>2. .3348 | 0.00175 | SUBTITLE D, 24" |
| CHES1958 | 1 | SUBDRY64 | SUBDRY64 | 1. .2549<br>2. .3348 | 1. .2749<br>2. .2680 | 0.00474 | SUBTITLE D, 24" |
| CHES1976 | 1 | SUBDRY65 | SUBDRY65 | 1. .2749<br>2. .2680 | 1. .2002<br>2. .2616 | 0.00829 | SUBTITLE D, 24" |
| CHESTAVE | 60 | SBDRY125 | SBDRY125 | 1. .2002<br>2. .2616 | 1. .3301<br>2. .3353 | 0.04348 | SUBTITLE D, 24" |

The following Table juxtaposes the modeling results for the 36" ET and Subtitle D covers, incorporating the five driest years:

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| Climate Model | Number of Years | Closure Cap Design | Average Annual Percolation (Inches) | Average Annual Percolation (Inches) | Closure Cap Design |
|---|---|---|---|---|---|
| CHESTAVE | 60 | Subtitle D 24" | 0.04501 | 0.02293 | 36" ET |
| CHES1956 | 1 | Subtitle D 24" | 0.015116 | 0.0145 | 36" ET |
| CHES1974 | 1 | Subtitle D 24" | 0.00095 | 0.00004 | 36" ET |
| CHES1950 | 1 | Subtitle D 24" | 0.00175 | 0.00002 | 36" ET |
| CHES1958 | 1 | Subtitle D 24" | 0.00474 | 0.00009 | 36" ET |
| CHES1976 | 1 | Subtitle D 24" | 0.00829 | 0.00001 | 36" ET |
| CHESTAVE | 60 | Subtitle D 24" | 0.04348 | 0.02240 | 36" ET |

## 18 SUCCESSFUL DEMONSTRATION

The two sets of models tabulated above present 250 years of HELP3 simulations. The 36" ET cover performed better in all but one year: 1984. That year is the third wettest year. The ET cover outperformed the Subtitle D cover during the first sixty years of average climate, the wettest year, the second wettest year, the fourth wettest year, the fifth wettest year, and for an additional 60 years of average climate thereafter. The ET cover also outperformed the Subtitle D cover throughout the entire set of driest year simulations.

The UDSHW has communicated to Gary F. Player several times that Subtitle D covers should not be expected to perform as well as modeled by HELP3. The reasons for the failure of the Subtitle D clay barrier cap are:

(1) Cracking after drying (dessication cracks);
(2) Enlargement of cracks due to Utah's active freeze-thaw cycle; and
(3) Propagation of cracks due to landfill settlement.

The HELP3 model predicted that moisture contents in the lower, barrier clay layer would be reduced below the wilting point of default soil 25 (.266 vol./vol.) after the "driest" years 1956 and 1976. The predicted moisture content after 1956 was .2616 vol./vol., and the predicted moisture content after 1976 was also .2616 vol./vol. The moisture content for barrier soil in Subtitle D cover models in the years following 1956 and 1976 were manually set at .266 vol./vol., creating a conservative set of parameters for moisture content in the "driest years" set of models.

### 18.1 Comparison of Total Percolation Through Each Cap

The total amount of moisture percolating through each cap during the 250 years modeled is summarized in the following Table:

| Climate Model | Number of Years | Closure Cap Design | Total Percolation (inches) | | [illegible] | Closure Cap Design |
|---|---|---|---|---|---|---|
| CHESTAVE | 60 | Subtitle D 24" | 2.7006 | | 1.3758 | 36" ET |
| CHES1983 | 1 | Subtitle D 24" | 2.02997 | | 0.76160 | 36" ET |
| CHES1980 | 1 | Subtitle D 24" | 2.71888 | | 2.33192 | 36" ET |
| CHES1984 | 1 | Subtitle D 24" | 0.06708 | | 0.69701 | 36" ET |
| CHES1995 | 1 | Subtitle D 24" | 1.667987 | | 0.01279 | 36" ET |
| CHES1998 | 1 | Subtitle D 24" | 0.00148 | | 0.00001 | 36" ET |
| CHESTAVE | 60 | Subtitle D 24" | 2.2014 | | 1.65 | 36" ET |

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| | | | | | | |
|---|---|---|---|---|---|---|
| **125 YEARS TOTAL** | **(WETTEST)** | **Subtitle D 24"** | **11.387397** | | **6.82912** | **36" ET** |

| Climate Model | Number of Years | Closure Cap Design | Total Percolation (Inches) | | [redacted] | Closure Cap Design |
|---|---|---|---|---|---|---|
| CHESTAVE | 60 | Subtitle D 24" | 2.7006 | | 1.3758 | 36" ET |
| CHES1956 | 1 | Subtitle D 24" | 0.015116 | | 0.0145 | 36" ET |
| CHES1974 | 1 | Subtitle D 24" | 0.00095 | | 0.00004 | 36" ET |
| CHES1950 | 1 | Subtitle D 24" | 0.00175 | | 0.00002 | 36" ET |
| CHES1958 | 1 | Subtitle D 24" | 0.00474 | | 0.00009 | 36" ET |
| CHES1976 | 1 | Subtitle D 24" | 0.00829 | | 0.00001 | 36" ET |
| CHESTAVE | 60 | Subtitle D 24" | 2.6088 | | 1.344 | 36" ET |
| **125 YEARS TOTAL** | **(DRIEST)** | **Subtitle D 24"** | **5.340246** | | **2.73446** | **36" ET** |
| **250 YEARS TOTAL** | **(ALL MODELS)** | **Subtitle D 24"** | **16.727643** | | **9.56358** | **36" ET** |

### 18.2 Conclusions about Leachate Percolation

The 36" ET cover cap has been shown to perform significantly better than the Subtitle D 24" cap in 249 out of 250 years modeled.

The total amount of leachate predicted from the Subtitle D cap over the 125-year period including the wettest years is 1.67 times greater than the leachate predicted from the 36" ET cap during the same period. The total amount of leachate predicted from the Subtitle D cap over the 125-year period including the driest years is 1.95 times greater than the leachate predicted from the 36" ET cap during the same period. The total amount of leachate predicted from the Subtitle D cap over the entire 250 year period is 1.75 times greater than the leachate predicted from the 36" ET cap during the same period.

The HELP3 model does not take into account the likely cracking and consequent failure of the Subtitle D barrier clay layer.

# PART VI--INFORMATION CONTAINED IN THE MARCH 22, 2004 LETTER

After a thorough review of site conditions and computer modeling predictions of leachate at Chester, the Sanpete Sanitary Landfill Cooperative and their consultants concluded that the proposed 36-inch thick cap of locally excavated fine-grained soils is a more stringent design than the standard design specified in Subsection R315-303-3(4)(a) to protect human health or the environment. We have also concluded that the proposed 36-inch thick cap meets the published regulatory requirements of the U.S. Environmental Protection Agency and the Utah Division of Solid and Hazardous Waste.

## 19 COMPARISON OF PERCOLATION RATES FOR ET AND SUBTITLE D CLOSURE CAPS

Two sets of HELP3 models have been presented to UDSHW. The first set was included in the Sanpete Sanitary Landfill Cooperative Class II Landfill Closure Plan, April 16, 2003. The following Table 1 (repeated from April 16, 2003) shows that, given the same climatic conditions, the proposed 36-inch ET final closure cap performs twice as well as a prescribed Subtitle D clay cap. Both caps discharged some water after the two wettest years, but then were effective for the next 68 modeled years. Documentation for the data shown in this and the other Tables in this letter were presented to UDSHW in the respective reports.

| Year or Years | Thirty-six Inch ET Cover Percolation (Inches/Year) | Subtitle D Clay Cap Percolation (Inches/Year) |
|---|---|---|
| 60 Years with Average Climate | .02512 (.638 mm/yr) | .05463 (1.39 mm/yr) |
| 1983 as Year 61 (Wettest) | 1.44952 | 1.42499 |
| 1980 as Year 62 | 4.04740 | 5.66077 |
| 1984 as Year 63 | .00002 | .00300 |
| 1995 as Year 64 | .000125 | .08115 |
| 1998 as Year 65 | .00000 | .00421 |
| 1956 as Year 66 | .00001 | .00143 |
| 1974 as Year 67 | .00000 | .01549 |
| 1950 as Year 68 | .00004 | .21401 |
| 1958 as Year 69 | .00025 | .66049 |
| 1976 as Year 70 (Driest) | .00001 | .00146 |
| 60 More Years with Average Climate, total of 130 years | .02505 | .05456 |

# 20 APPLICABLE REGULATIONS

40 CFR Chapter 1 (7-1-96 Edition) lists acceptable closure criteria for municipal solid waste landfills. Section 258.60 (a) describes the so-called "standard" Subtitle D cover as follows:

> The final cover system must be designed and constructed to: (1) have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils

present, or a permeability no greater than $1X10^{-5}$ cm/sec, whichever is less, and (2) minimize infiltration through the closed MSWLF by the use of an infiltration layer that contains a minimum of 18- inches of earthen material, and (3) minimize erosion of the final cover by the use of an erosion layer that contains a minimum 6-inches of earthen material that is capable of sustaining native plant growth.

Section 258.60 (b) then states that the Director of an approved state may approve an alternative final cover design that includes:

(1) An infiltration layer that achieves an equivalent reduction in infiltration as the infiltration layer specified in paragraphs (a)(1) and (a)(2) of this section, and (2) an erosion layer that provides equivalent protection from wind and water erosion as the erosion layer specified in paragraph (a)(3) of this section.

Utah, an approved state, has promulgated the following regulation concerning closure caps in R-315-303-3, Standards for Design. Section R315-303-3(4) states that, at closure, the owner or operator of a Class II landfill (such as the Chester Landfill) shall use one of the following designs for the final cover:

(a) Standard design. The standard design of the final cover shall consist of two layers:
(I) a layer to minimize infiltration, consisting of at least 18 inches of compacted soil, or equivalent, with a permeability of $1 X 10^{-5}$ cm/sec or less, or equivalent, shall be placed upon the final lifts;
(A) in no case shall the cover of the final lifts by more permeable than the bottom liner system or natural subsoils present in the unit; and
(B) the grade of surface slopes shall not be less than 2%, nor the grade of side slopes more than 33%, except where construction integrity and the integrity of erosion control can be demonstrated at steeper slopes; and
(II) a layer to minimize erosion, consisting of:
(A) at least 6 inches of soil capable of sustaining vegetative growth placed over the compacted soil cover and seeded with grass, other shallow rooted vegetation, or other native vegetation; or
(B) other suitable material, approved by the Executive Secretary.

(b) Alternative Design. The Executive Secretary may approve an alternative final cover design, on a site specific basis, if it can be documented that:

> (I) the alternative final cover achieves an equivalent reduction in infiltration as specified as the standard design in Subsection R315-303-0(4)(a)(I); and
> (II) the alternative final cover provides equivalent protection from wind and water erosion as specified as the standard design in Subsection R315-303-3(4)(b)(ii)

The Solid Waste Permitting and Management Rules, dated October 15, 2003, include a third, more stringent, alternative closure cap alternative:

> ( c ) If a landfill has been constructed using an approved alternative landfill design, including a waiver, or exemption, from the liner or ground water monitoring requirements, the Executive Secretary may require, on a site specific basis, the landfill closure to be a more stringent design than the standard design specified in Subsection R315-303-3(4)(a) to protect human health or the environment.

Sanpete has provided a design for a more stringent closure cap than the Subtitle D cap specified in R315-303-3(4)(a). Computer modeling summarized above demonstrates that over a 130-year period the proposed 36-inch closure cap would allow infiltration of a little less than half as much moisture as a standard design described in Subsection R315-303-3(4)(a).

Tables included in the July 31, 2003 Letter Report show infiltration through The Subtitle D standard design after 250 years would total 1.75 times more infiltration than would penetrate the proposed 36" thick evapotranspiration final cover cap in the same period. Therefore, the proposed landfill closure cap is a "more stringent design" than the standard design specified in Subsection R315-303-3(4)(a) to protect human health or the environment.

The last row from the comparison table in our July 31, 2003 letter is repeated below with columns rearranged and an additional row showing average annual infiltration:

| Climate Model | Number of Years | Percolation (inches) | Closure Cap Design | | [illegible] Cap [illegible] | Percolation (inches) |
|---|---|---|---|---|---|---|
| (ALL MODELS) | 250 YEARS TOTAL | 9.56358 | 36" ET | | Subtitle D 24" | 16.727643 |
| (ALL MODELS) | 250 YEARS AVERAGE | .03825 | 36" ET | | Subtitle D 24" | .06691 |

# 21 FINAL COVER DESIGN

## 21.1 Materials

The infiltration layer for the final cover will be constructed of shallow soils obtained from the first ten feet of soils in a pit on the landfill property. The soils in the first 10 feet below ground level are clay loams, with a USCS class name of clay (CL), and a saturated hydraulic conductivity less than 3.26 X $10^{-5}$ centimeters per second, when compacted to at least 90% of maximum dry density.

Copies of analyses of the soils from the surface to ten feet below ground level are presented in Appendices I and II.

## 21.2Thickness

The evapotranspiration cover will be at least 36 inches thick. This thickness does not include intermediate cover soils that have already been placed over most of the landfill prism. The thickness of the cover may be increased to reflect measured quantities of gravel coarser than 2 millimeters.

## 21.3 Construction Procedures

The ET cap will not be installed at "greater than optimum" moisture content (as is required for a Subtitle D prescriptive cap), but with relatively dry soil at field conditions typical of Sanpete County. For that reason, the ET cover will be much less prone to damage from dessication or freeze-thaw cycles than a prescribed Subtitle D compacted clay cap.

A Landfill Closure Construction Plan will be submitted to UDSHW for approval by the Executive Secretary before constructing the final cover. The Plan will illustrate how the final cover will be installed and will include construction drawings and a Quality Assurance/Quality Control plan.

Respectfully Submitted,

Gary F. Player
Utah Professional Geologist No. 5280804-2250

Doug Bjerregaard
Chairman, Sanpete Sanitary
Landfill Cooperative

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## FIGURES

Figure One: Map of the Class II Landfill.

Figures Two A and B: Final Cover Plan and Cross Sections.

Figure Three: Class IVb Landfill Map

Figure Four: Map showing Landfill slopes as measured with a hand level and compass, and the location of run-on control berms.

Figure Five: Map showing the drainage area, culverts through Highway 89 and the railroad grade, and breaches in the railroad grade south of the Landfill gate.

## APPENDICES

Appendix I: Copies of soil analyses prepared by Tri-State

Appendix II: Copies of soil analyses prepared by Geo Consultants.

## ATTACHMENTS

Attachment 1: Proof of Ownership

Attachment 2: Annual Reporting Form

Attachment 3: Field Inspection Form

Attachment 4: A cost estimate for placing final cover and reseeding, obtained from Jensen Construction, Manti, Utah.

Attachment 5: A scanned copy of part of the most recent Chester, Utah, U.S. Geological Survey (USGS) topographic map of the site area.

# REFERENCES

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# FIGURES

# ATTACHMENTS

# APPENDICES