2.0 CLOSURE AND POST CLOSURE PLAN

2.1 Cap Design
The final cap proposed for this site consists of an earthen final cover consisting of 24” of loamy, fine sand that will minimize infiltration, provide for a vegetative layer, provide a stable long term cap to isolate the waste, protect ground water quality, and support post closure land use.

2.1.1 Cap Performance Goals
The hydraulic performance of the proposed cap was modeled with EPA’s HELP model. A detailed discussion and calculations are included in Volume 2, Section 4.6.\textsuperscript{8} The HELP model demonstrates annual infiltration through the cap to be approximately 0.18”, a value which is protective of ground water quality at the landfill point of compliance. Infiltration will seep slowly into the ash waste and will provide moisture to fully hydrate the moisture-deficient ash such that no free moisture will leave the waste mass for well over 100 years.\textsuperscript{9} When the ash is fully hydrated and reaches field capacity, excess moisture will seep from the waste though the unsaturated zone to underlying ground water. Fate and transport modeling included in Volume 2, Section 4 demonstrates excess water will not impact ground water quality as a percentage of the Maximum Contaminant Level (MCL) at the point of compliance.\textsuperscript{10} When the ash fully hydrates, it has the potential to release moisture equal to the cap flux. The fate and transport modeling in Volume 2 demonstrates ground water quality will not be significantly impacted with flux values up to 2”/yr.\textsuperscript{11} Long-term steady state flow conditions are reached when the landfill free moisture reaches the underlying ground water and the ground water flows outward to the point of compliance. Fate and transport modeling has demonstrated no significant impacts to ground water when this steady state condition is reached. Consequently, the cap proposed achieves the goal of permanently protecting ground water quality.

\textsuperscript{9} Ibid., p. 46.
\textsuperscript{10} Ibid., p. 66.
\textsuperscript{11} Ibid., p. 66.
2.1.2 Soil Properties and Testing Requirements for Cap Construction

The soil used for cap construction should be loamy fine sand. This type soil is best illustrated by the Soil Triangle of Basic Soil Textural Classes, Figure 1. Loamy fine sand typically has very little clay (10-15%), some silt (up to 30%), and sand (70-85%). More important than the exact proportion of the soil makeup, are the hydraulic properties of the soil itself. The HELP model has default values of porosity, field capacity, and wilting point that it uses in lieu of actual values. For loamy fine sands, the default values for the HELP model are 45.7% for porosity, 13.1% for field capacity, and 5.8% for wilting point. Candidate soils do not necessarily have to meet these values, but should behave similarly to achieve desired flux or infiltration rate.

A model sensitivity analysis was conducted by Natural Resource Technology, Inc. (NRT) in preparing Volume 2. This analysis demonstrated flux for onsite loamy fine sand to be 0.18"/yr. with a measured porosity of 38.2% and field capacity of 20.1%. NRT ran additional simulations and found soil porosity values of up to 44% and field capacity values of 15% or greater will maintain soil cap flux values protective of ground water quality.

The loamy fine sand used for cap construction must possess the following properties in order for it to be used for cap construction.

- Porosity $\leq 44\%$
- Field Capacity $\geq 15\%$

2.1.3 Geotechnical Assessment Testing

In February 2006, a geotechnical assessment was performed to locate and collect samples from alluvial soil horizons known to occur at the Holcomb site. The assessment included

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13 John Boschuk, Jr., JLT Laboratories, Inc., Geotechnical Test Results, Holcomb Landfill, March 10, 2006.
FIGURE 1

USDA TEXTURAL CLASSIFICATION
288-D-2473

Client : Sunflower Electric
Project : Holcomb Landfill
Material : Super Composite
Date : 02/17/2006
Project No. : 06LS788.01
Perf’d By : RO
Chk’d By : JB

BASED ON MATERIAL PASSING #10 SIEVE
(Refer to gradation curve, ASTM D-422)

<table>
<thead>
<tr>
<th>LOWER</th>
<th>DIFFERENCE</th>
<th>PLOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAND</td>
<td>% 19.00</td>
<td>79.80</td>
</tr>
<tr>
<td>SILT</td>
<td>% 12.00</td>
<td>7.00</td>
</tr>
<tr>
<td>CLAY</td>
<td>% 0.00</td>
<td>12.00</td>
</tr>
</tbody>
</table>

TOTAL 100.00 %

SAMPLE NO : SW-7/SW-8
DEPTH : Feet
CLASSIFICATION
SANDY LOAM

PERCENTAGES OF CLAY (BELOW 0.002 mm), SILT (0.002 TO 0.05 mm), AND SAND (0.05 TO 2.0 mm) IN THE BASE OF SOIL TEXTURAL CLASSES
SOIL TRIANGLE OF BASIC SOIL TEXTURAL CLASSES. (U.S. SOIL CONSERVATION SERVICE) 288-D-2473
drilling ten soil borings at five locations in two regions. The first region is located southeast of the Holcomb Plant (Borings SW 9, 10, and 11) and the second region is located adjacent to the landfill (Borings SW 7 and 8). The landfill boring locations are shown on Figure 2. Appendix D includes a narrative and bore hole logs for geotechnical testing.

Boring depths ranged from 15 to 25' and samples were collected continuously using five foot split spoon samplers. Sample cores obtained during drilling were logged and composite samples were collected for laboratory analysis.

Soils collected from alluvial zones were composited into new five gallon buckets for transport to JLT Laboratories of Canonsburg, PA. Two samples were submitted for geotechnical analyses: SW 9/10/11 composite and SW 7/8 composite. Soil testing results by JLT Laboratories are included in Volume 2, Appendix G.¹⁴

2.1.4 Soil Testing Summary
A total of five soil samples were shipped to JLT Laboratories, Inc. of Canonsburg, PA for testing. The five samples were SW 7/8 composite; SW 9/10/11 composite; SW 8/9/10 composite; SW 10 duplicate; and SW 11 composite. The soil samples were first tested for particle size distribution with results plotted on the Soil Triangle of Basic Soil Textural Classes for soil classification. Two composite soil samples of loamy fine sand (SW 7/8 composite and SW 9/10/11 composite) were selected for additional testing.

A density-moisture curve was generated for samples SW 7/8 composite and SW 9/10/11 composite. SW 7/8 was found to have a maximum dry density (MDD) of 112.4pcf with an optimum moisture content of 10.8%. The as received, moisture content of SW 7/8 composite was 6%. A 92% of maximum dry density was selected for additional testing to simulate field compaction efforts in the event this soil is used for soil cap construction.

Similarly, SW 9/10/11 composite was found to have a maximum dry density of 116.4 pcf with an optimum water content of 12.4%. The as received moisture content of SW 9/10/11 composite was 7%. A 92% of maximum dry density was selected for additional testing to simulate field compaction efforts in the event this soil is used for soil cap construction. Results indicate both soil samples to be similar but SW 7/8 composite was preferred due to better hydraulic properties and proximity to the landfill site.

Additional testing of SW 7/8 composite included hydraulic conductivity, porosity, field capacity, and wilting point. The latter three tests are direct inputs for the HELP model to simulate flux through the soil cap. The soil samples were compacted at 92% maximum dry density to simulate field compaction efforts. Test results for SW 7/8 composite are as follows:

<table>
<thead>
<tr>
<th>Soil Classification</th>
<th>Sandy loam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydraulic Conductivity</td>
<td>5.09x10^{-6} cm/sec</td>
</tr>
<tr>
<td>Porosity</td>
<td>38.16%</td>
</tr>
<tr>
<td>Field Capacity</td>
<td>20.13%</td>
</tr>
<tr>
<td>Wilting Point</td>
<td>3.95%</td>
</tr>
</tbody>
</table>

Based on these results, it was determined the SW 7/8 composite area soil meets the requirements for use in the soil cap. Similarly, SW 7/8 composite meets the definition of loamy fine sand and possesses soil properties including porosity, field capacity and wilting point that retain moisture to ensure flux sufficient to protect ground water quality.

Actual soil test results were used in the HELP model simulations (Volume 2, Section 4, pages 40-42) to ensure the resulting flux values are below the allowed rate.\(^{15}\)

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2.1.5 **Cap Construction**

Soil for the final cap will be applied over the ash in two lifts of 1 foot each. Figure 3 presents cross section of the landfill cap. The soil will be compacted to 92% maximum dry density using heavy equipment to achieve this modest level of compaction. Once the 24" of soil is in place, a cover crop will be applied to establish initial vegetative cover.

The Permittee will seed forage sorghum (variety canex) at 20 lbs. per acre in mid-May to early July. The sorghum will be irrigated as necessary to establish a cover reaching a height of 30 inches. Fertilizer will then be applied at a rate of phosphorous (P2O5) of 50 lbs./ac. Manure may be used in place of commercial fertilizer with an equivalent rate of phosphorous of 50 lbs/ac. For example, if manure has phosphorous at 0.35%, the equivalent manure application rate would be 7 tons/acre. When the sorghum reaches 30" in height, it should be mowed to a height of six inches with clippings left in place.

The following April, the Permittee will seed 6.5 lbs/ac. of the seed mix (Table 1) directly into the sorghum using a no-till seed drill. No additional fertilizer is needed.

Alternatively, manure application may be used for the landfill cap top in place of commercial fertilizer. Commercial fertilizer will be applied on side slopes covered with SprayMatt® mulch. (See Appendix F for SprayMatt® product information).

Loamy fine sand is native to the area and will support vegetation as well as hold moisture to support the native grasses as vegetative cover. Irrigation will be applied to the cap after seeding and fertilizing to attain a 50% vegetative cover. After that, irrigation will only be used in case of drought or to address small areas of poor vegetative cover. Grazing will not be allowed on the landfill cap.

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17 Kansas State University Telephone Conversation Log, Appendix D.
18 Erickson, same reference as footnote 14, p. 22.
TABLE 1
NATIVE SEED MIX FOR
VEGETATIVE COVER\textsuperscript{19}

<table>
<thead>
<tr>
<th>Seeding</th>
<th>Sorghum (variety canex)</th>
<th>20 lbs/ac.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Native Seed for Cap</td>
<td>Sand Bluestem</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td>Little Bluestem</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>Indiangrass</td>
<td>1.4</td>
</tr>
<tr>
<td></td>
<td>Switchgrass</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>Sand Lovegrass</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>Side oats gramma</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>Blue gramma</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>Alkali sacaton</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>Sand dropseed</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.5 lbs/ac</td>
</tr>
</tbody>
</table>

Seeds shall be free of prohibited weed seeds and shall not have more than 1% of noxious weed seeds. Seeds shall be delivered to the site in containers, each fully labeled, bearing the name, or trade mark and a warranty of the producer and a certificate of the percentage of the purity and germination of each kind of seed specified. The tags shall be made available to the engineer for filing.

Fertilizer

Fertilizer shall be minimized as it promotes weed growth. Fertilizer shall be applied at a rate of phosphorous (P\textsubscript{2}O\textsubscript{5}) of 50 lbs/ac. Manure may be used in place of commercial fertilizer after testing for phosphorus and applying manure at an equivalent phosphorous application rate. Commercial fertilizer shall be uniform in composition, free flowing, and delivered to the site in standard size bags, showing weight, analysis, and name of manufacturer. It shall be stored until use in a weatherproof storage place in such a manner that it will be kept dry and its effectiveness will not be impaired. The fertilizer shall be uniformly distributed over the site.

The borrow area for loamy fine sand is the property immediately adjacent to the landfill footprint, particularly areas south and west of the landfill site. Other on site soils and mixtures may be used for borrow soil after they have been tested to verify suitability. All borrow areas will be graded to blend in with surrounding topography and seeded and fertilized in accordance with seeding specifications in Table 1 for native grasses. The soil borings for the borrow area are shown in Figure 2.

2.2 Cap Construction Schedule
Cap construction will be undertaken as each phase is filled. The Permittee will notify KDHE at least 30 days in advance before cap construction activities begin. Table 2 presents the area of final cover at the conclusion of each phase. Closure activities will be initiated within 30 days after each phase if landfilled to its design capacity, except as outlined herein. The Permittee will monitor waste fill elevations to ensure each phase is filled to the appropriate elevation and design slopes. Cap construction will follow the approved design and the CQA requirements. The Permittee may elect to construct a cap over a portion of a phase before it is completely full. In this event, the Permittee will notify KDHE 30 days before cap construction activities begin and identify the portion of the phase to be closed. A PLS will survey all closed areas and document all capped phases for future reference and inspections. A licensed Kansas professional engineer will oversee cap construction and will so certify and submit to KDHE for approval.

While it is the goal to begin closure activities within 30 days after each phase or area reaches capacity and to complete closure within 180 days, this may not always be feasible. These deadlines may be extended if the Permittee demonstrates to KDHE that closure will, of necessity, take longer than 30 days to begin and 180 days to complete. Inclement weather and seasonal weather conditions may not allow for closure activities to begin for up to 6 months after reaching phase capacity and closure may not be achieved for up to 270 days from start of phase closure. The Permittee will work to minimize the time required for phase or area closure.
2.3 Final Slopes and Elevation

Completed slopes and final elevations of the cap are presented on Drawing E-E008, Volume 3. The Permittee will fill all phases to within 2' of the elevations shown to allow for cap construction. Minimum slopes across the landfill top are 2% and maximum side slopes are 15%. Interior fill slopes may reach 3:1 but are only temporary and will be filled in as the landfill progresses. Bench drains and slope drains are shown on Drawing E-E008, Volume 3.

The Permittee will survey top of waste and top of cap to verify slopes and cap thickness. As-built drawings will be prepared based on a site survey by a Kansas PLS to document cap construction of each phase. Drawings will be prepared and certified by a Kansas Professional Engineer.
### Table 2
**Phase Summary Table**

<table>
<thead>
<tr>
<th>Phase</th>
<th>Waste Volume (cubic yards)</th>
<th>Active Disposal Area (^1) (acres)</th>
<th>Inactive Disposal Area to Basin (^2) (acres)</th>
<th>Area of Intermediate Cover Needed (acres)</th>
<th>Area Capped and Closed (acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(^4)</td>
<td>19.6</td>
<td>0</td>
<td>10.2</td>
<td>9.6</td>
<td>10.2*</td>
</tr>
<tr>
<td>2A(^4)</td>
<td>522,200</td>
<td>17.4</td>
<td>10.2</td>
<td>9.6</td>
<td>0</td>
</tr>
<tr>
<td>2B</td>
<td>969,000</td>
<td>13.3</td>
<td>19.8</td>
<td>10.2</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>1,673,300</td>
<td>29.4</td>
<td>33.1</td>
<td>0</td>
<td>20.0</td>
</tr>
<tr>
<td>4</td>
<td>2,702,500</td>
<td>36.4</td>
<td>10.2</td>
<td>8.6</td>
<td>13.3</td>
</tr>
<tr>
<td>5</td>
<td>834,300</td>
<td>18.3</td>
<td>10.2</td>
<td>0</td>
<td>14.5</td>
</tr>
<tr>
<td>6</td>
<td>273,900</td>
<td>17.0</td>
<td>10.2</td>
<td>0</td>
<td>17.0</td>
</tr>
<tr>
<td>7</td>
<td>1,014,300</td>
<td>24.0</td>
<td>17.0</td>
<td>0</td>
<td>19.5</td>
</tr>
<tr>
<td>8</td>
<td>2,992,500</td>
<td>40.4</td>
<td>11.6</td>
<td>0</td>
<td>31.1</td>
</tr>
<tr>
<td>9</td>
<td>2,567,200</td>
<td>34.1</td>
<td>5.5</td>
<td>0</td>
<td>22.2</td>
</tr>
<tr>
<td>10(^3)</td>
<td>694,800</td>
<td>18.2</td>
<td>12.4</td>
<td>0</td>
<td>15.3</td>
</tr>
<tr>
<td>11</td>
<td>1,185,100</td>
<td>25.4</td>
<td>12.4</td>
<td>0</td>
<td>35.1</td>
</tr>
<tr>
<td>Totals</td>
<td>15,429,100</td>
<td>---</td>
<td>---</td>
<td>28.4</td>
<td>188</td>
</tr>
</tbody>
</table>

**Notes:**

1. Includes disposal area of current phase and of adjacent phases as appropriate.
2. Some inactive areas not to be used in the succeeding phase, with intermediate cover applied, will be diverted around the evaporation basin. These areas are not accounted for in this column's values.
3. Taken from GAI Engineering Report, Volume 3, 3/06.
4. 1.4 million cy of waste previously landfilled in Phases 1 & 2. Permit modification for 15.4 million cy in addition to the 1.4 million cy filled as of 2/05.

* 10.2 acres capped in Phase 1 will be filled over in subsequent phases so this is not reflected in the 188 acre total.
2.4 Irrigation of Vegetative Cover

Establishment of vegetative cover on the final cap is important to prevent water and wind erosion. The Permittee will use native grasses for the final cap and will irrigate newly constructed capped areas as required to establish a suitable vegetative cover. Newly capped areas will be irrigated to establish the sorghum as the cover crop and then only in the event natural precipitation is not sufficient to provide needed moisture. Irrigation may continue until the cover crop reaches 50% coverage. At that point, irrigation will be discontinued unless drought conditions exist or small localized areas are reseeded to establish vegetative cover.

2.5 Cap and Vegetative Cover Maintenance

Vegetative cover will be maintained by the Permittee through the post closure period. The vegetative cover will be fertilized on an as needed basis (typically no greater than once every three years). Soil samples will be collected every 3 years (an interval) and forwarded to the Kansas State University extension office for soil nutrient testing. Testing will include pH, potassium, nitrogen, and phosphorous. Two soil samples per phase will be collected. Soil testing will no longer be necessary if two consecutive intervals of soil testing prove the soil nutrient levels are sufficiently high. Irrigation will be used to establish the sorghum vegetative cover but should not be necessary once this cover is firmly established. Once the sorghum cover reaches approximately 30” high, it will be cut. Clippings will be allowed to remain in place to supplement soil nutrient levels and protect from erosion. Any areas observed to experience wind or water erosion will be promptly repaired. Soil from borrow areas will be brought to damaged areas and applied as required. Seed and fertilizer will be applied with mulch as necessary.

Grazing of the landfill vegetative cover will not be allowed due to the possibility of over-grazing and harming the vegetative cover. The landfill area will be fenced as necessary to prevent grazing.
2.6 Closure Certification

Following closure of each phase, the Permittee will submit a certification prepared by the CQA Engineer to KDHE stating the closure for that phase was completed in substantial compliance with the approved plans. The certification will include a short summary report detailing the activities completed with all CQA test data and documentation attached. As-built plans of the final cap will be submitted documenting construction of the final cap.

A CQA Report and Certification will be issued to KDHE when the entire landfill is closed as well as when individual phases of the landfill are closed. The CQA Plan will identify any significant discrepancies between the approved design and the landfill as closed.

When the vegetative cover is established and KDHE has approved the closure certification, the 30 year post closure period may begin for that phase.

Any deviations from the approved Closure Plan will be coordinated with KDHE and, as appropriate, be incorporated into the final CQA Report.

2.7 Post Closure Period and Post Closure Certification

The Landfill will enter into the 30 year post closure period when the closure certification for each phase is accepted and approved by KDHE. The Permittee will monitor the landfill for a period of 30 years and maintain the vegetative cap. Post closure activities include cap maintenance, ground water monitoring, vegetation maintenance, and record keeping. Following completion of the post closure care period for each phase, The Permittee will submit a certification to the Director of KDHE prepared by a licensed Kansas professional engineer certifying post closure care has been completed in accordance with the approved post closure plan.
2.8 Post Closure Inspections
The Permittee will be responsible for cap maintenance and conduct annual post closure inspections for each phase. The inspections will be recorded on an inspection form as shown on Figure 4. A Kansas licensed Professional Engineer will conduct Post Closure inspections every fifth year.

2.9 Ground Water Monitoring and Testing
Ground water sampling and testing is to be done in accordance with a KDHE approved Sampling and Analysis Plan (SAP). Samples will be analyzed in accordance with the approved Sampling and Analysis Plan. Depth to water will be measured and recorded. Sampling protocol, chain of custody procedures, holding times and preservatives, and reporting requirements are included in the Sampling and Analysis Plan, Appendix H, Volume 2.