Section 5
Operation Plan

The proposed bioreactor design is a combined system that injects leachate and water into the waste and collects landfill gas as it is generated. The system incorporates separate conveyance piping for the two functions to maintain separation between the processes. The combined system incorporates a network of piping installed over the surface of the landfill and horizontal injection trenches (HITs), surficial gravity trenches (SGTs), and vertical injection wells (VIWs) that are constructed within the waste. These components are designed to operate in either wetting mode or gas collection mode but never simultaneously.

5.1 Pressure Injection System

The existing leachate storage pond will serve as the source of leachate and water for the injection process. A submersible pump, located at the existing pump station in the leachate pond will be used to transfer leachate and water to the HITs and VIWs. The layout of the piping and HIT/VIW system is shown on Sheet 8. The components of the pressure injection system include:

- Force Main - a network of pressure pipe that conveys the leachate from the pond to the HITs and VIWs. The perimeter force main connects to the main header pipes in ten locations. Each connection point is valved to provide a single point of control for each HIT/VIW network. The lateral header pipes are aligned perpendicular to the landfill sideslope and connect HITs and VIWs along the same elevation. The lateral header pipes will be expanded periodically during the filling operation as new HITs and VIWs are installed. When the final cover is installed, liner boots will be used for valve stem penetrations.

- HIT - a perforated HDPE pipe in a stone-filled trench that is installed within the waste during operation. The HIT provide the pathway through which the leachate and water are applied to the waste. A valve is located at the connection point of the HIT to the lateral header pipe to provide control of leachate flow to individual HIT.

- VIW – a slotted PVC pipe installed in a vertical borehole that is surrounded with stone. The VIW will be installed in phases as areas of the landfill reach final grade.

The pumping process will be manually controlled with an operator positioned at the selected HIT/VIW and another operator positioned at the injection pump. The operators will coordinate using two-way radios to control the injection flow rate and pressure.

The procedures outlined below are a general guideline for operating the pressure injection system. It is anticipated that operational procedures will be progressively

modified to provide the most efficient and effective wetting program as the operators gain experience with the system.

5.2 Pumping Strategy

The goal of the bioreactor operation is to promote decomposition throughout the entire landfill. Stabilization is achieved by anaerobically decomposing the organic fraction of the waste in the landfill. This goal is achieved by providing a uniform dispersal of water and nutrients thus avoiding dry pockets in the landfill. The HITs are spaced horizontally and vertically to provide optimal coverage of the waste in the landfill. In areas that cannot be accessed by HITs, the injection process will be performed using VIWs.

In addition to uniform dispersal it is equally important that a sufficient amount of water is introduced to provide a favorable environment for microbial activity. The water balance calculations (refer to Appendix A) determine the amount of water to be added to the waste in order to reach an optimum level of moisture. However, it is very important that the rate of application is controlled as recommended by Reinhart and Townsend (Landfill Bioreactor Design & Operation, 1998). An attempt to achieve the desired moisture content of 45% too rapidly can cause several problems:

- Depleting the buffering capacity of the waste and killing methanogens. The creation of high concentrations of volatile organic acids can cause a "stuck" condition in which methanogens cannot thrive.
- Creating saturated conditions that decrease stability of the waste and stagnate the biological processes.

To prevent these occurrences from happening, the recommended approach is to add the leachate and water in small doses over a period of time. A rotation schedule will be established that will be updated as new components are installed. This will allow time between injections for the water to drain and to be absorbed by the waste. The rotation schedule will be based on maintaining a 2-week resting period between injection events and achieving the desired moisture content within a 2 to 3 year timeframe. The amount of leachate or water to be injected in a single event will be calculated based on the capacity of each HIT/VIW. Applying water in small doses has also been demonstrated to benefit propagation of microbes as a result of frequent nutrient transfer.

The ultimate quantity of leachate and water to be pumped is based on the zone of influence of each injection component and the desired moisture content of the waste to promote biodegradation. The zone of influence will be calculated based on the spacing between the trenches and wells and the length/depth of the HIT/VIW. The ultimate quantity will be determined by calculating the zone of influence in terms of cubic yards of waste and multiplying that value by a calculated amount of gallons of

water required for each cubic yard of waste. The single event and ultimate quantities of leachate and water to be injected will be determined prior to beginning the operation.

5.3 General Procedures

1. Each component is equipped to inject leachate or water and collect gas. These processes should never be operated simultaneously. Concurrent operation of leachate recirculation and gas collection will result in flooding of the gas collection header. A minimum of 30 vertical feet of waste will be placed over an HIT before initiating injection.

2. The injection pressure should be maintained between 10 and 15 psi to maintain adequate dispersion and to prevent pore pressure buildup in areas with limited depth of waste. The injection pressure for the initial event should be at 15 psi to obtain maximum lateral dispersion at a time when the waste is less compacted. .

   Throttling the butterfly valves located at the injection pump will control the pumping pressure. By monitoring the pressure gauge at the inlet and slowly increasing the flow rate by opening the butterfly valve, the operator on the landfill can inform the pump operator when to stop opening the valve. Valve throttling will be required most often at the lower elevations because the static head is relatively low.

3. The landfill side slopes must be carefully inspected during the period after pumping to determine if leachate seeps are occurring (staining, erosion, isolated wet areas, etc.). After each injection event a minimum two week draining period is recommended before injecting again. The operator will establish a pumping rotation schedule that will provide a draining period for all active components. The trenches and wells will be labeled in the field with the designations assigned in Sheets 5 and 6 so that it may be identified and listed in the pumping rotation schedule. The schedule will be revised to include new components in the rotation as they are installed

4. After the draining period, the operator should check for gas pressure by inspecting the pressure gauge installed at the inlet. If the gauge indicates a buildup of pressure, the valve on the gas distribution pipe should be opened to allow analysis of the gas at the wellhead. If the presence of gas is confirmed and there is no sign of leachate flooding the line, then gas collection can be operated until the next scheduled injection event. Important: The wellheads should be installed with clear flexible tubing to allow the gas system operator to visibly check for leachate flow.

5.4 Detailed Procedures

1. For monitoring purposes, it is recommended that the injections be performed one at a time. Further consideration of pumping into multiple units will be made after gaining experience with the system. The first step in performing the injection is to adjust the valves of the system to the proper settings.

   Open the header valve to the desired network and close the header valves of the other networks. Open the leachate valve at the selected unit and close the leachate valves of all other units within the same network. Close the valve of the gas wellhead at the selected unit. **Important: Since most of the HIT have injection ports at both ends it is very important that the operator check the valves at the end not being used to ensure it is closed.**

2. Position operators at the HIT/VIW and the injection pump. The operators are to be equipped with two-way radios for communication during the pumping process. Once the operator at the HIT/VIW has confirmed that the valve settings are correct, he will notify the operator at the pump to activate the pump. Depending on the elevation of the HIT/VIW, the butterfly valve at the pump may require adjustment to maintain the desired pumping pressure. The operator at the HIT/VIW will direct the pump operator on the required adjustment.

3. The operator at the pump will record the flowmeter reading prior to pumping and at the completion of pumping so that the quantity of leachate or water pumped into the HIT/VIW can be calculated.

4. The operator at the HIT/VIW will monitor the pressure gauge as the pumping progresses. The pressure will increase as the HIT/VIW fills and then stabilize as the leachate begins to infiltrate the surrounding waste. This stabilized pressure will be referred to as the injection pressure. The injection pressure should be maintained at approximately 15 psi or less. The operator at the pump will adjust the butterfly valve according to the directions of the operator at the HIT/VIW. The HIT/VIW operator should record the pressure reading at 15-minute intervals to track the progress of the injection. Changes in the injection pressure will indicate when the HIT/VIW is being recharged and when the liquid is being pumped into the waste.

5. Pumping will stop when the injection quantity is obtained. At that time the pump operator will shut down the pump and notify the HIT/VIW operator to close the leachate control valve.

5.5 Direct Application at the Working Face

Water will be applied at the working face as a supplement to the injection operation. Direct application at the time of initial placement will ensure that all waste is wetted

to some extent. The application will be performed using a water truck to transport water from the onsite groundwater well to the working face where it will be applied to the waste by a hose or spray bar. The quantity of water applied will be recorded and credited towards the quantity required to meet the target moisture content. To avoid human contact, the application will only be performed during periods when waste haulers and other landfill staff are not present. Direct application will not occur during periods of precipitation or windy conditions. The amount of water applied will be limited to quantities that do not cause runoff and the area of application will be properly prepared to contain the water in the active cell. This will be achieved by installing small berms as necessary. No liquid will be applied once daily cover has been placed over the working face. The potential for odor problems will exist in hot weather conditions. The direct application operation may be suspended at times as necessary to control odors.

5.6 Other Operational Considerations

As discussed on page 16 of the FPA, use of cover material should be addressed for proper functioning of the bioreactor. Soil materials, left in place, can lead to preferential flow paths (sandy soils) or perched water conditions (clay soils). If possible, the use of alternative daily covers such as tarps or spray application material is preferred since the barrier is not permanent. It is recommended that intermediate cover soils be removed, to the extent possible, before placing additional lifts of waste. Experience demonstrates that it is not possible to remove 100% of the cover material since some of it falls into voids in the waste. In any case, disruption of the continuous soil layer will aid in the prevention of side seeps and perched water. The bulk of the cover material can be removed with a dozer and then agitated to break up the cover layer.

Consideration should also be given to compaction of the waste. Decreasing the compaction effort during waste placement will promote greater dispersion of the leachate and water being injected and allow more of the waste to be moisturized. By maximizing the wetting operation, more of the organic fraction of the waste will be decomposed. Reduced compaction may ultimately result in an increase of the overall capacity of the landfill through increased settlement.

An important point to keep in mind concerning HIT installation is that it is an ongoing process that needs to be coordinated with the filling operation. Once additional lifts of waste are placed over an elevation planned for trench installation, the window of opportunity is missed and the only options remaining are to drill or omit the trench. For this reason, the site manager needs to closely monitor the progress of the filling operation to provide ample notice to his staff when additional trenches are to be installed. This requires that the site manager frequently review the phasing plan provided on Sheets 2, 3, and 4 of the drawings that show the specific filling stage for each HIT/VIW installation. It is also recommended that surveys be

performed quarterly of the active filling area that can be used in conjunction with the phasing plan to schedule installations.

5.7 Gas Collection System

Landfill gas will be collected from the waste utilizing the combined injection / gas collection system and the leachate collection system. The combined system is designed with separate piping for gas collection and injection functions. The layout of the piping network that will be used for gas collection is shown on Sheet 7. The components of the system include:

- Gas main - an HDPE pipe that imparts the vacuum to the lateral piping and conveys the gas from the laterals to the flare station;
- Lateral piping- an HDPE pipe that conveys gas from the HIT / VIW / SGT to the gas main;
- HIT / VIW / SGT – the various conduit that provides the means by which the gas is collected from the waste;
- Gas wellhead connection - this assembly will connect the lateral piping to the HIT / VIW / SGT, the wellhead includes a sampling port to monitor gas composition and pressure, and a temperature gauge.

The components of the system are detailed on Sheets 9 and 10.

Gas will also be collected from the leachate collection system. The components of this system that will be utilized for gas collection are shown in more detail on Sheet 9 and include the following:

- Gas main - the same header described above, this header will be connected to the leachate cleanouts and slope risers;
- Leachate cleanout - the solid HDPE pipe that provides connection between surface and perforated leachate collection pipe;
- Perforated leachate collection piping - a perforated HDPE pipe in the leachate collection layer; gas will be collected from the open space in the pipe above the leachate;
- Gas wellhead connection - the same as described above; a series of HDPE pipes and fittings will connect the header to the wellhead on the berm surface at the cleanout.

The gas header is connected to the cleanouts of the header collection pipes and slope risers at the low end of each cell. These connections will include a gas wellhead assembly.

5.7.1 Gas Collection System Operation Strategy

The operation of the gas collection system is consistent with the description provided on pages 15 and 16 of the FPA. It is anticipated that the gas collection system will operate continuously. The gas collection system will be monitored and adjusted routinely by Buncombe personnel to maximize system performance. The HITs will be utilized for gas extraction as the filling progresses. The VIWs and SGTs will be installed and activated in areas after final grades are obtained. The operational phasing of the landfill is as shown on Sheets 2, 3, and 4. It is anticipated that the uppermost layers (which will change as the filling progresses vertically) will be used primarily for gas collection to control odors and gas emissions. The lower areas will be used for both injection and gas collection as dictated by the injection rotation schedule. The HITs will operate jointly with the leachate collection system to envelop the gas being generated within the landfill.

During operation of the gas collection system the operator will monitor and adjust the active gas extraction points of the collection system as needed to maximize system performance. Pressure, temperature, methane and oxygen concentrations at the active extraction points will be monitored at each wellhead. The operator will adjust the system as indicated by the monitoring results. The vacuum applied at individual extraction points may be adjusted using the valve provided at the wellhead connection. The vacuum can also be adjusted at the blower. However, if the vacuum is adjusted at the blower, the collection points throughout the system must be evaluated for performance.

5.7.2 Gas Collection System Operational Procedures

The procedures outlined below are a general guideline for operating the gas collection system. It is anticipated that operational procedures will be progressively modified to provide the most efficient and effective wetting program as the operators gain experience with the system.

Each trench is equipped to inject leachate and water and collect gas. Since the wetting process will accelerate the generation of gas it is important that the gas collection system be operable, including a flare station, before beginning the injection operation. Also, these processes should never be operated simultaneously in a HIT / VIW / SGT. Concurrent operation of injection and gas collection will result in flooding of the gas collection system. Monitoring of the pressure gauges at the head of each HIT / VIW will provide indication of when gas generation has reached a level that warrants collection.

The following criteria must be met before activating gas collection:

- A minimum of 20-feet of waste must be present over an HIT. This is required to prevent air intrusion into the system.

- A minimum of 1 week of draining time must be allowed before collecting gas from an HIT/VIW/SGT that has been recently injected.

After the draining period, the HIT/VIW/SGT should be checked weekly for gas pressure by inspecting the pressure gauge. If the gauge indicates a buildup of pressure, the valve on the gas distribution pipe should be opened to allow analysis of the gas at the wellhead. If the presence of gas is confirmed and there is no sign of leachate flow, then gas collection can be operated until the next scheduled injection event. The wellheads should be installed with clear flexible tubing to allow the operator to visibly check for leachate flow.

The leachate collection system will also be utilized to collect gas from the landfill. Wellheads will be installed at the cleanouts and slope riser of the leachate collection system. It is anticipated that approximately 20-feet of compacted waste will be adequate to prevent air intrusion, however, the system may be operated at shallower depths if it is demonstrated that air intrusion is not occurring during the initial use of a leachate collection pipe for gas collection.

Gas collection will be performed using the leachate collection piping and the uppermost tier of HIT at any given time during the operation of the landfill. The system is designed to promote gas collection at the bottom and top of the waste mass by creating negative pressure in these two zones. The injection of leachate into HITs in the center of the waste is anticipated to enhance collection in these two zones through the filling of air voids with leachate (i.e., the gas will be forced to migrate to less saturated zones). However, after a large number of HITs and VIWs are installed, gas collection will also be performed in the middle zone. Any HITs or VIWs that have been draining for more than 1 week after being injected may also be used for gas collection. The rotation employed for gas collection will correspond directly with the injection rotation schedule.

The following sample scenario illustrates the intended use of the combined system:

- HIT 3-21 are installed
- HIT 19-21 are used for gas collection after 20-feet of are placed over them.
- HIT 3-20 are used alternately for leachate injection or gas collection according to the established criteria stated above.

The leachate collection system of Cell 6 is used for gas collection.

5.7.3 Condensate Management

The gas collection system laterals are sloped at a minimum 3% to drain condensate to the knockouts or the drip legs. For the laterals with longer lengths, the condensate is

directed to drip legs and contained within the liner system to be collected as leachate in the leachate collection system. The condensate drip legs are shown in Detail F on Sheet 9. All other pipes drain condensate to one of the knockouts located on the perimeter of the landfill. The perimeter gas main is sloped to match the grade of the containment berm. These slopes are sufficient to drain condensate to the knockouts and will not be reduced due to settlement since the berm is located outside the limits of the waste.