4 WEST-SIDE ANAEROBIC CELL

The west-side anaerobic cell is located on the western 6 acres of Phase 1, Module D. Filling in the west-side anaerobic cell was complete in August 2002 with a total of 166,294 tons of waste placed.

4.1 Experimental

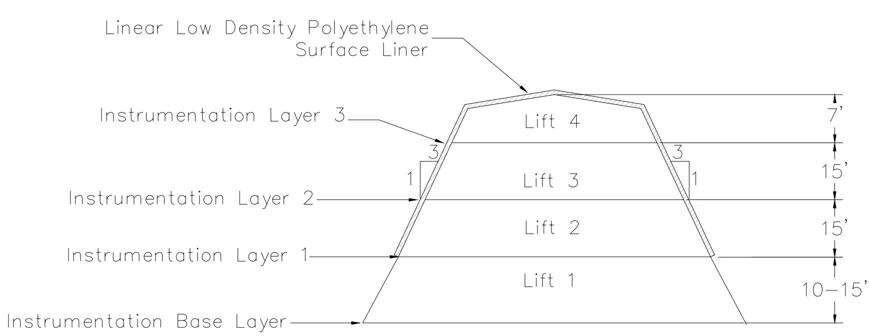
The experimental methods utilized are grouped into three categories: construction, monitoring, and operation. Each of these categories is discussed below.

4.1.1 Construction

Construction of the west-side anaerobic cell can be generally broken down into four major tasks: waste placement, liquid addition, gas collection, and surface liner installation. Each of these four tasks is discussed below. A summary of current monitoring data for the west-side anaerobic cell is provided in Appendix A, Table 4-1.

4.1.1.1 Waste Placement

Waste placement began on March 8, 2001 and was completed on August 31, 2002. Waste was placed in four lifts of approximately 15-foot thickness with 2.5:1 side slopes on interior slopes and 3:1 on exterior slopes (Detail 4-1, Image 4-1). All waste received at the landfill was deposited in the west-side cell (i.e. no class of waste was excluded). The use of daily cover soil during waste filling was minimized to aid in the overall permeability of the waste. Whenever possible, greenwaste or tarps were used as alternative daily cover (ADC) and, in the event soil was placed (for example, access roads or tipping pad), the soil was removed prior to placing the next lift of waste. Instrumentation Layers 1, 2, and 3 were placed between lifts, and base layer instrumentation was installed on the Module 6D base liner.



Detail 4-1. Cross Section of West-Side Anaerobic Cell

Image 4-1: Waste placement in the west-side cell

4.1.1.2 Liquid Addition

Horizontal liquid injection lines were installed between lifts 2 and 3, and 3 and 4 approximately every 40 feet. In addition, three injection lines were installed on top of lift 4, spaced every 25 feet. Each injection line consists of a 1.25-inch-diameter high-density polyethylene (HDPE) pipe placed horizontally (east to west), which extends completely through the waste. Each injection line was perforated by drilling a $^1/_8$ or $^3/_{32}$-inch hole every 10 or 20 feet (depending on which line). A total of 7,185 feet of injection piping was installed with a total of 321 injection holes.

Each of the injection laterals will be connected to a 4-inch-diameter HDPE injection header. Leachate injection for each lateral will be monitored and controlled by individual solenoid valves connected to the SCADA system. A flow meter will monitor the total volume and injection flow rate for the entire northeast anaerobic cell.

4.1.1.3 Gas Collection

Horizontal landfill gas (LFG) collection lines were installed between lifts 2 and 3, and 3 and 4, and on top of lift 4. The LFG collection lines consist of various combinations of alternating 4 and 6-inch diameter schedule 80 and schedule 40 polyvinyl chloride (PVC) pipe as well as several variations of corrugated metal pipe and electrical conduit. At each line, shredded tires were used as the permeable media. A total of eighteen LFG collection lines were installed. A summary of gas collection lines for the northeast anaerobic cell is provided in Appendix A, Table 4-2.

Each LFG collection line is connected to a 6-inch or 8-inch diameter LFG collection header that conveys the gas to the on-site LFG-to-energy facility. Each LFG collection line incorporates a valve capable of controlling flow and a port for monitoring gas composition, temperature, pressure, and flow rate.

4.1.1.4 Surface Liner

Vector was retained to provide design, plans and specifications for a surface lining system (refer to section 3.1.1.4). In contrast to the northeast anaerobic cell, which utilized a reinforced polypropylene membrane (RPP), a 40-mil linear low-density (LLDPE) geomembrane material was selected because it offered a greatly reduced cost. The installation of the surface liner was completed in October 2002 (Image 4-2).

Image 4-2: West-side anaerobic cell surface liner.

4.1.2 Monitoring

Temperature, moisture, leachate quantity and quality, and LFG pressure and composition are monitored through an array of sensors placed within the waste and in the leachate collection and recovery system (LCRS). Each sensor location received a temperature sensor (thermistor), a linear low-density polyethylene (LLDPE) tube, and a moisture sensor (a PVC moisture sensor and in some cases a gypsum block). For protection, each wire and tube was encased in either a 1.25-inch HDPE pipe or run inside the LFG collection piping. Refer to Appendix B, Details 4-2 through 4-4 for sensor location diagrams.

4.1.2.1 Temperature

Temperature is monitored with thermistors manufactured by Quality Thermistor, Inc. Thermistors with a temperature range of 0°C to 100°C were chosen to accommodate the temperature ranges expected in both the anaerobic and aerobic cells. To prevent corrosion, each thermistor was encased in epoxy and set in a stainless steel sleeve. All field wiring connections were made by first soldering the connection, then covering each solder joint with adhesive-lined heat shrink tubing, and then encasing the joint in electrical epoxy. Changes in temperature are measured by the change in thermistor resistivity (ohms). As temperature increases, thermistor resistance decreases.

4.1.2.2 Moisture

Moisture levels are measured with polyvinyl chloride (PVC) moisture sensors and gypsum blocks. Both the PVC moisture sensors and gypsum blocks are read utilizing the same meter. The PVC sensors are perforated 2-inch-diameter PVC pipes with two stainless steel screws spaced 8 inches apart and attached to wires to form a circuit that includes the gravel filled pipe. The PVC sensors were designed by Yolo County and used successfully during the pilot scale project. The PVC moisture sensor can provide a general, qualitative assessment of the waste's moisture content. A reading of 0 to 40 equates to no free liquid, 40 to 80 equates to some free liquid, and 80 to 100 means completely saturated conditions.

4.1.2.3 Leachate Quantity and Quality

Leachate that is generated from the west-side anaerobic cell drains to the west-side Module D leachate collection sump. A dedicated pump is then used to remove the leachate and pump it to one of the on-site leachate storage ponds. A flow meter measures rate and total volume pumped from the sump.

Leachate is monitored for the following field parameters: pH, electrical conductivity, dissolved oxygen, oxidation-reduction potential, and temperature. When leachate is generated in sufficient quantities, the following parameters will be analyzed by a laboratory: dissolved solids, biochemical oxygen demand, chemical oxygen demand, organic carbon, nutrients (NH_3, TKN, TP), common ions, heavy metals and organic priority pollutants. For the first year of liquid injection, monitoring will be conducted monthly for the first six months and quarterly for the following six months. After the first year, monitoring will be conducted semi-annually (pH, conductivity, and flow rate will continue to be monitored on a monthly basis as required by the State of California's Waste Discharge Requirements in Order 5-00-134).

4.1.2.4 Pressure

Pressure within the northeast anaerobic cell is monitored with ¼-inch inner diameter and $^{3}/_{8}$-inch outer diameter LLDPE sampling tubes. Each tube can be attached to a pressure gage and supplemental air source. By first purging the tube with the air source (to remove any liquid blockages) and then reading the pressure, an accurate gas and/or water pressure can be measured at each sensor location.

4.1.2.5 Landfill Gas Composition and Flow

Landfill gas composition and flow are measured from the well heads utilizing a GEM-500 combustible gas meter, manufactured by LANDTEC, in combination with a 1/8-inch diameter pitot tube, manufactured by DWYER Instruments, Inc.. The GEM-500 is capable of measuring methane (either as a percent by volume or percent of the lower explosive limit), carbon dioxide, and oxygen. A reading for "balance" gas is also provided, which is assumed to be nitrogen. Currently, gas composition is analyzed from the same sampling tubes used to measure pressure.

4.1.2.6 Waste Sampling

Yolo County conducted the first waste sampling event for the west-side anaerobic cell on June 5, 2002. Waste was sampled to quantify the methane generation potential of the waste. Waste was drilled to an approximate depth of 35 feet with samples taken at approximately 5 feet intervals.

Waste will be sampled from the west-side anaerobic cell annually for the next two years to monitor the progress of waste decomposition and compare actual methane generation to laboratory methane generation.

4.1.2.7 Surface Scan

Under current federal guidelines (40 CFR 60.752), landfills exceeding a specific size must monitor for methane surface emissions and any reading in excess of 500 PPM (40 CFR 60.755 (c)) requires corrective action to be taken. The Yolo County Central Landfill is not currently required to test for methane surface emissions, however, as part of the FPA, the County has proposed to conduct quarterly surface scans to demonstrate the emissions (or lack of) from a controlled bioreactor landfill.

Surface emissions were monitored with a model OVA-108 Flame Ionization Detector (FID) instrument in March 2003. The OVA-108 is capable of detecting methane in the parts-per-million (PPM) range and has an accuracy of ± 20 percent of reading. Surface emissions were previously monitored with a model TVA-1000 FID/Photo Ionization Detector (PID) instrument. Under the FID setting, the TVA-1000 is capable of detecting methane in the parts-per-million (PPM) range and has an accuracy of ± 2.5 PPM or 25 percent of the reading, whichever is greater. In the event significant methane was detected, the unit could be switched to PID mode to detect volatile organic compounds (VOC). Methane surface concentrations are monitored along the perimeter of the collection area and along a pattern that transverses the landfill at 15 meter intervals. Due to high winds and inclement weather, the surface scan scheduled for December 2002 was postponed until January 2003. A summary of the surface scans performed on the west-side anaerobic cell is presented below in Table 4-3.

Table 4-3. Summary of Surface Scans Performed on the West-Side Anaerobic Cell

Surface Scan No.	Date	Max. Emissions Detected	Location of Max. Emissions
1	April 3, 2002	50 ppm	Southwest corner of the cell
2	June 6, 2002	37 ppm	On top the cell, along the access road leading to the active waste placement area
3	September 19, 2002	124 ppm	Southwest corner of the cell. This area was rescanned and surface concentrations decreased to approximately 10 ppm.
4	January 8, 2003	30 ppm	Along the northern perimeter near piping from the leachate collection and removal system (LCRS).
5	March 19, 2003	150 ppm	Detected at three locations: (1) The northern perimeter of the cell near the LCRS piping, (2) the north face of the cell directly south of the perimeter and approximately 15 feet east of the LCRS piping, and (3) directly south of the top deck hinge point and approximately 15 feet west of the centerline of the cell.

Because the west-side cell was still undergoing active waste placement and a membrane cover had not been installed prior to the April 2002, June 2002 and September 2002 surface scans, greater methane emissions were detected from the west-side cell than from the northeast anaerobic cell. The detection of high surface emissions in March 2003 may be due to high background readings (between 60 and 75 ppm) and unsealed areas (less than 1 inch) where piping penetrates the surface liner. A follow-up surface scan will be performed in April 2003 to confirm these readings and steps will be taken to seal the pipe penetrations.

4.1.3 Operation
Operation of the west-side anaerobic cell will begin once the leachate recirculation system and SCADA control systems are complete.

4.1.3.1 Leachate Recirculation
Initially, large volumes of liquid will be added to bring the waste to field capacity. Once field capacity has been reached, only enough liquid to maintain field capacity will be added.

4.1.3.2 Landfill Gas Collection
Landfill gas collection began May 7, 2002, once the necessary piping was installed. Gas collection prior to leachate addition was necessary to prevent “billowing” or excess gas pressure under the surface liner.

4.2 Results And Discussion
Sensor names are represented numerically by the instrumentation layer in which the sensor is located and by the assigned sensor number for that layer. Layer 1 is represented by a 1, Layer 2 is represented by a 2, and so forth. The complete name of the sensor is denoted by the layer number – the sensor number. For example, the second sensor on Layer 1 is named 1-02.

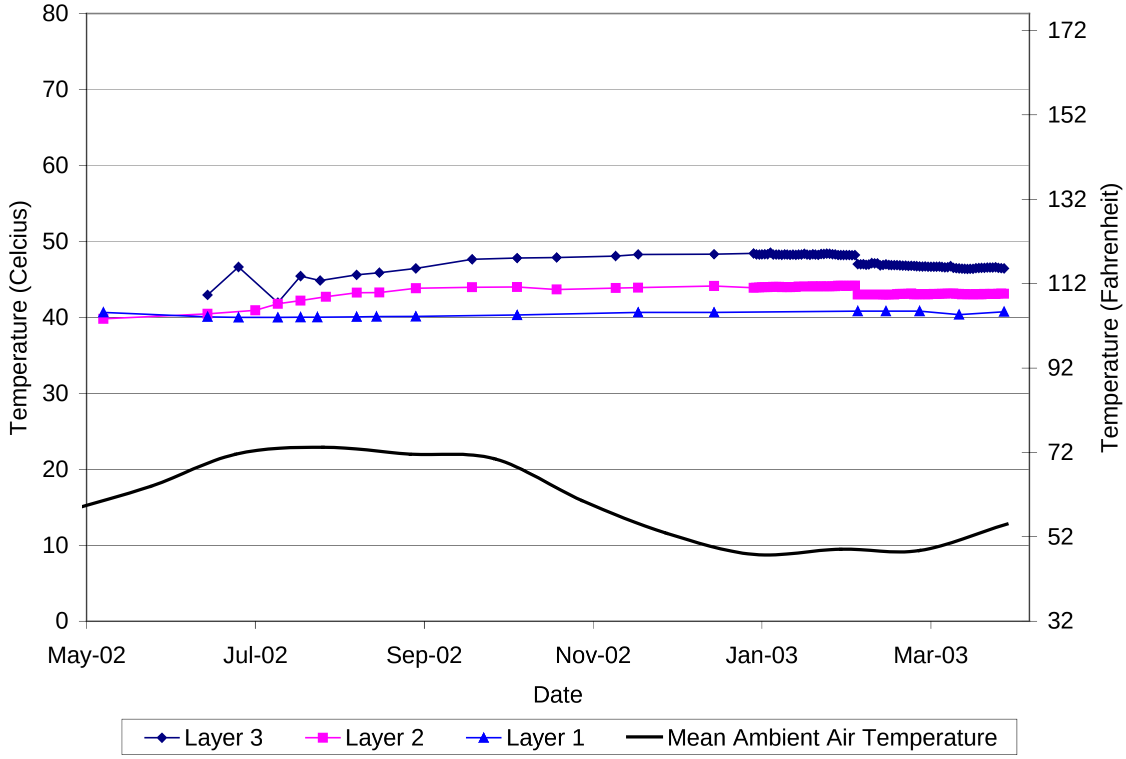
4.2.1 Temperature
Temperature is monitored with thermistors manufactured by Quality Thermistor, Inc. Thermistors with a temperature range of 0°C to 100°C were chosen so they would be able to accommodate the temperature ranges expected in both the anaerobic and aerobic cells. Currently, resistance was measured manually by connecting the sensor wires to a 26 III Multimeter manufactured by Fluke Corporation.

Temperature results are presented in Appendix C, Figures 4-1 to 4-3. A summary of the results is presented below in Table 4-4 and Figure 4-4.

Table 4-4. Temperature Summary for the West-Side Anaerobic Cell

	Previous Reporting Period (10/1/02 to12/31/02)			Current Reporting Period (1/1/03 to 3/31/03)		
Layer	Minimum Temp. (°C)	Maximum Temp. (°C)	Average Temp. (°C)	Minimum Temp. (°C)	Maximum Temp. (°C)	Average Temp. (°C)
1	34.3	43.8	40.5	37.7	42.8	40.7
2	43.7	45.6	44.4	27.8	49.9	43.5
3	43.9	58.8	48.1	42.8	54.8	47.4

Figure 4-4. Average Temperatures for the West-Side Anaerobic Cell



4.2.2 Moisture

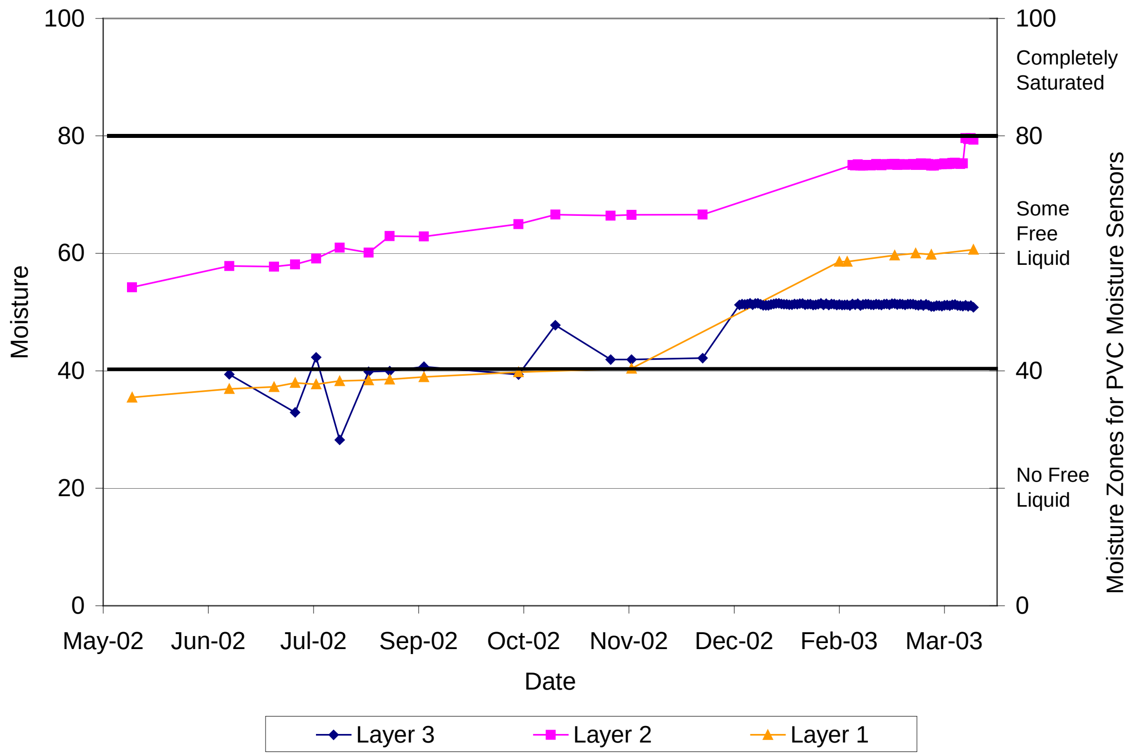
Moisture is measured manually with a Model MM 4 moisture meter manufactured by Electronics Unlimited. Moisture data are unitless numbers that give a qualitative assessment rather than a quantitative measure. During the pilot scale project, Yolo County conducted laboratory tests with the PVC sensors to determine the relationship between the multimeter readings and the presence of free liquid in the PVC sensor. It was determined that a meter reading of less than 40 corresponded to an absence of free liquid. A reading between 40 and 80 corresponds to the presence of free liquid in the PVC pipe but less than saturated conditions. Readings of greater than 80 indicate saturated conditions; i.e. the PVC sensor is full of liquid.

Moisture results are presented in Appendix C, Figures 4-5 to 4-7. A summary of the results is presented below in Table 4-5 and Figure 4-8.

Table 4-5. PVC Moisture Summary for the West-Side Anaerobic Cell

	Previous Reporting Period (10/1/02 to12/31/02)			Current Reporting Period (1/1/03 to 3/31/03)		
Layer	Minimum Moisture	Maximum Moisture	Average Moisture	Minimum Moisture	Maximum Moisture	Average Moisture
1	27.0	67.4	40.1	38.4	82.2	59.6
2	0.8	66.6	66.2	2.7	94.8	75.5
3	39.4	47.8	42.6	4.5	88.2	51.3

Figure 4-8. Average Moisture Levels for the West-Side Anaerobic Cell



4.2.3 Landfill Gas Collection System

Gas composition is measured from the base layer and the wellheads located on top of the west-side anaerobic cell with the GEM-500. Gas flow is measured by differential pressures utilizing a 1/8-inch diameter pitot tube by DWYER Instruments, Inc., in combination with the GEM-500. A thermal mass flow meter will be installed in the main header pipeline to record flow rate and total flow for west-side anaerobic cell.

Landfill gas results are presented in Appendix C, Figures 4-9 to 4-11. Methane concentrations from the wellhead fluctuate based on the applied vacuum, barometric pressure, and the status of waste decomposition. After surface liner installation in October 2002, the collection rate of landfill gas drastically increased. Additionally, methane and carbon dioxide concentrations increased while and oxygen and balance concentrations decreased. A summary of the results is presented below in Table 4-6.

Table 4-6. Landfill Gas Summary for the West-Side Anaerobic Cell.

Parameter	**Results**		
Cumulative Methane from May 7, 2002 to March 31, 2003	5.3×10^6 standard cubic feet (scf) (which is equivalent to approximately 850 barrels of oil)		
LFG Flow Rate for the period of January 1, 2003 to March 31, 2003	Minimum	Maximum	Average
	7 scf	47 scf	20 scf
Methane Concentration for the period of January 1, 2003 to March 31, 2003	Minimum	Maximum	Average
	33.4 %	46.7 %	40.1 %

Landfill gas was sampled from the west-side base layer wellhead in March 2003 and sent to an independent laboratory for analytical testing. Analytical results are presented in Appendix D. Landfill gas will be sampled on a quarterly basis when liquid addition commences in the west-side anaerobic cell.

4.2.4 Leachate Quantity And Quality

Prior to October 2001, leachate data reflects rainfall rather than actual leachate generation because the cells were only partially filled, and portions of the leachate collection and removal system were exposed to rainfall. Between October 2001 and March 2003, approximately 116,000 gallons of leachate was generated from the west-side cell (Appendix C, Figure 4-12).

Leachate was last sampled in February 2003 for analytical testing. Analytical results are presented in Appendix E, Table 4-7. Field chemistry and selected analytical results are presented below in Table 4-8. Analytical results show only a decline in COD, conductivity, metals, and volatile organic compounds since February 2002. Leachate will be sampled on a monthly basis once liquid addition commences.