FULL SCALE BIOREACTOR LANDFILL FOR CARBON SEQUESTRATION AND GREENHOUSE EMISSION CONTROL

Quarterly Technical Progress Report

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ABSTRACT

The Yolo County Department of Planning and Public Works is constructing a full-scale bioreactor landfill as a part of the Environmental Protection Agency's (EPA) Project XL program to develop innovative approaches for carbon sequestration and greenhouse emission control. The overall objective is to manage landfill solid waste for rapid waste decomposition and maximum landfill gas generation and capture for carbon sequestration and greenhouse emission control. Waste decomposition is accelerated by improving conditions for either the aerobic or anaerobic biological processes and involves circulating controlled quantities of liquid (leachate, groundwater, gray water, etc.), and, in the aerobic process, large volumes of air.

The first phase of the project entails the construction of a 12-acre module that contains a 6-acre anaerobic cell, a 3.5-acre anaerobic cell, and a 2.5-acre aerobic cell at the Yolo County Central Landfill near Davis, California. The cells are highly instrumented to monitor bioreactor performance. Liquid addition has commenced in the 3.5-acre anaerobic cell and the 6-acre anaerobic cell. Construction of the 2.5-acre aerobic cell and biofilter has been completed. The remaining task to be completed is to test the biofilter prior to operation, which is currently anticipated to begin in January 2004. The current project status and preliminary monitoring results are summarized in this report.

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1 EXECUTIVE SUMMARY

In 1996, Yolo County began operation of a pilot-scale project to evaluate the costs and benefits of a relatively new concept in landfill operation, often termed “bioreactor” or “enhanced” landfilling. The basic concept of a bioreactor landfill is to increase the biological activity of the waste (through the addition of water) to maximize the production of landfill gas for carbon sequestration and greenhouse emission control. The results of this pilot project were favorable and, as a result, Yolo County requested and gained approval from state and federal regulatory agencies to conduct this full-scale demonstration of bioreactor landfilling.

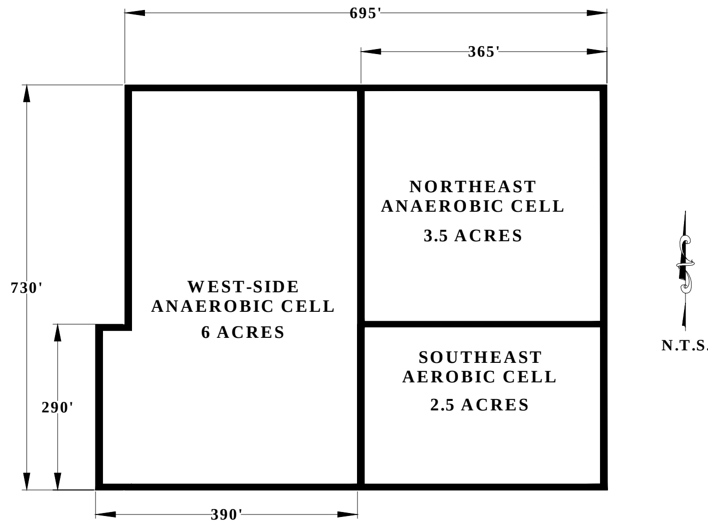
Because current Federal and California State regulations generally do not allow the addition (or recirculation) of leachate and other supplemental liquid to a lined landfill module, special regulatory flexibility was required to conduct this project. Yolo County applied for, and was granted the necessary flexibility through the Unites States Environmental Protection Agency XL Program which stands for "eXcellence and Leadership.” The XL program allows state and local governments, businesses and federal facilities to develop with EPA innovative strategies to test better or more cost-effective ways of achieving environmental and public health protection.

This report provides an update on Phase 1 of the Yolo County Accelerated Anaerobic and Aerobic Composting (Bioreactor) Project where carbon sequestration and greenhouse emission is controlled through either the anaerobic or aerobic process. Phase 1 of the project encompasses a 12-acre area of a 20-acre landfill module (Unit 6, Module D) at the Yolo County Central Landfill. Phase 2 of the project has begun with the construction of the primary liner system and installation of 12 temperature and moisture sensors. Waste placement in Phase 2 began in November 2002.

1.1 Summary of Current Project Status

The majority of the bioreactor project continues on schedule with the only deviations related to the aerobic cell’s air collection system. The project schedule is located in Appendix A, Table 1-1 and has been altered since the previous project schedule prepared in April 2003.

The project is separated into three landfill cells, two cells will be operated anaerobically and one aerobically (Detail 1-1). We have designated the three bioreactor cells as the west-side anaerobic cell, the northeast anaerobic cell, and the southeast aerobic cell. This configuration allowed the northeast anaerobic cell to be constructed and operated prior to completion of the west-side anaerobic cell. By separating the anaerobic bioreactor into two separate cells, experiences gained from construction of the northeast cell were incorporated into the west-side anaerobic cell.



Detail 1-1. Overview of Module D Bioreactor Cells

The northeast anaerobic cell, the west-side anaerobic cell, and the southeast aerobic cell have been filled with waste and instrumentation. A total of 65,104 tons of waste was placed in the northeast anaerobic, 11,942 tons of waste was placed in the southeast aerobic module, and 166,294 tons of waste was placed in the west-side anaerobic cell. The gas collection systems and leachate injection systems have been completed in the northeast anaerobic cell, the west-side anaerobic cell, and the aerobic cell.

The installation of a reinforced polypropylene (RPP) membrane surface cover over the northeast anaerobic cell was completed in November 2001 and will allow precise quantification of the amount of landfill gas produced by eliminating surface emissions. The aerobic cell received a cover of 12-inches of soil overlaid by 12-inches of greenwaste alternative daily cover (ADC). The surface membrane cover for the west-side anaerobic cell is similar to the northeast anaerobic cell, with the exception that 40-mil linear low-density polyethylene (LLDPE) was used instead of RPP. Surface liner installation for the west-side anaerobic cell was completed in October 2002.

A Supervisory Control and Data Acquisition (SCADA) system has been installed and monitors and controls the operation of the bioreactor cells. To date, all instrumentation installed in the northeast and west-side anaerobic cells, the aerobic cell, and on the Module 6D composite liner have been connected to a central processor which is radio linked to a computer located in our Woodland office. In March 2002, the SCADA system started to electronically collect temperature and moisture data from in the northeast anaerobic cell, the aerobic cell, and on the Module 6D composite liner. In January 2003, the SCADA system started to electronically collect temperature and moisture data from in the west-side anaerobic cell.

Landfill gas collection began in the northeast anaerobic cell in mid-December 2001. Through the end of September 2003, a total of 39.6 x 10^6 scf of methane (which is equivalent to approximately 6,285 barrels of oil) has been collected and utilized at the on-site gas to energy facility. Landfill gas collection began in the west-side anaerobic cell in May 2002, and through the end of

September 2003 a total of 15.7 x 10^6 scf of methane (which is equivalent to approximately 2,492 barrels of oil) has been collected and utilized at the on-site gas to energy facility. Landfill gas was sampled from the northeast anaerobic cell and the west-side anaerobic cell submitted for laboratory analysis in August 2003. Gas composition (methane, carbon dioxide, and oxygen) continues to be monitored on a weekly basis.

Landfill gas collection from the aerobic cell began on January 13, 2003. Through the end of September 2003, a total of 528,716 scf of methane (which is equivalent to approximately 84 barrels of oil) was collected and sent to the on-site gas to energy facility. Once operation of the aerobic cell commences, the off-gas will be sent to the biofilter for treatment. Landfill gas was sampled for laboratory analysis in August 2003.

Leachate addition to the northeast anaerobic cell began on March 27, 2002. Through the end of September 2003, a total of 1,766,077 gallons of supplemental liquid have been added and 881,243 gallons of leachate recirculated to the northeast anaerobic cell. Leachate was monitored for field chemistry and sampled for laboratory analysis in August 2003.

Leachate addition to the west-side anaerobic cell began on June 5,2003. Through the end of September 2003, a total of 1,900,625 gallons of supplemental liquid has been added and 3,600 gallons of leachate recirculated to the west-side anaerobic cell. Leachate was monitored for field chemistry and sampled for laboratory analysis in July 2003.

Monitoring for methane surface emissions has been performed quarterly since April 2002. During this reporting period, a surface scan of was performed on the bioreactor cells in September 2003. The highest methane surface emissions detected on the west-side anaerobic cell in September 2003 were 59.3 parts per million (ppm) on the east face of the cell. The high readings for the west-side anaerobic cell are due to small gaps (less than 1 inch) in the surface liner where piping exits the cell (pipe penetrations). In order to eliminate emissions from the west-side anaerobic cell, Yolo County will be sealing the pipe penetrations. In September 2003, no methane surface emissions were detected from the northeast anaerobic cell and the highest methane surface emissions detected from aerobic cell were 48.9 ppm in the sump area on the south end of the cell.

On July 15 and 16, Yolo County conducted the second round of waste sampling from the bioreactor cells. Two boreholes were drilled in each of the bioreactor cells and waste samples were taken approximately every 5 feet. Samples were tested in the field for pH and then packaged and sent to a laboratory to be analyzed for biochemical methane potential (BMP).

2 INTRODUCTION

Sanitary landfilling is the dominant method of solid waste disposal in the United States, accounting for about 217 million tons of waste annually (U.S. EPA, 1997). The annual production of municipal solid waste in the United States has more than doubled since 1960. In spite of increasing rates of reuse and recycling, population and economic growth will continue to render landfilling as an important and necessary component of solid waste management.

In a Bioreactor Landfill, controlled quantities of liquid (leachate, groundwater, grey-water, etc.) are added to increase the moisture content of the waste. Leachate is then recirculated as necessary to maintain the moisture content of the waste at or near it's moisture holding capacity. This process significantly increases the biodegradation rate of waste and thus decreases the waste stabilization and composting time (5 to 10 years) relative to what would occur within a conventional landfill (30 to 50 years or more). If the waste decomposes (i. E., is composted) in the absence of oxygen (anaerobically), it produces landfill gas (biogas). Biogas is primarily a mixture of methane, a potent greenhouse gas, carbon dioxide, and small amounts of Volatile Organic Compounds (VOC's). This by-product of anaerobic landfill waste composting can be a substantial renewable energy resource that can be recovered for electricity or other uses. Other benefits of a bioreactor landfill composting operation include increased landfill waste settlement and a resulting increase in landfill capacity and life, improved opportunities for treatment of leachate liquid that may drain from fractions of the waste, possible reduction of landfill post-closure management time and activities, landfill mining, and abatement of greenhouse gases through highly efficient methane capture over a much shorter period of time than is typical of waste management through conventional landfilling.

2.1 Description Of The Project And Its Purpose

The County of Yolo Planning and Public Works Department (Yolo County) is operating its next 20-acre landfill module near Davis, California as a controlled bioreactor landfill to attain a number of superior environmental and cost savings benefits. In the first phase of this 20-acre project, a 12-acre module will be constructed. This 12-acre module contains a 6-acre cell and a 3.5-acre cell, which will be operated anaerobically, and a 2.5-acre cell, which will be operated aerobically. The County began construction the second phase of Module 6D in Fall 2002 and, depending on the results of the first phase of Module 6D, Yolo County may operate the second phase either anaerobically or aerobically.

Co-sponsors of the project with Yolo County are the Solid Waste Association of North America (SWANA) and Institute for Environmental Management (IEM, Inc.). As part of the EPA Project XL, Yolo County requested that U.S. EPA grant site-specific regulatory flexibility from the prohibition in 40 CFR 258.28 Liquid Restrictions, which may preclude addition of useful bulk or non-containerized liquid amendments. The County intends to use leachate and groundwater first but if not enough liquid is available then other supplemental liquids such as gray-water from a waste water treatment plant, septic waste, and food-processing wastes will be used. Liquid wastes such as these, that normally have no beneficial use, may instead beneficially enhance the biodegradation of solid waste.

Yolo County also requested similar flexibility on liquid amendments from California and local regulatory entities. Several sections of the California Code of Regulations (CCR), Title 27, Environmental Protection, address the recirculation of liquids in lined municipal solid waste landfills. While the regulations do not specifically endorse bioreactors, regulatory flexibility is provided by the State of California Title 27, Chapter 3, Subchapter 2, Article 2, section 20200, Part (d)(3), *Management of liquids at Landfills and Waste Piles*. For additional information on this regulatory flexibility, see Section IV A of the FPA.

2.2 Description Of The Facility And The Operations / Geographic Area

The Yolo County Central Landfill (YCCL) is an existing Class III non-hazardous municipal solid waste landfill. The site encompasses a total of 722 acres and is comprised of 17 distinct Class III solid waste management units and two Class II leachate surface impoundments. The YCCL is located at the intersection of Road 104 and Road 28H, 2 miles northeast of the City of Davis. The YCCL was opened in 1975 for the disposal of non-hazardous solid waste, construction debris, and non-hazardous liquid waste. Existing on-site operations include a thirteen-year-old landfill methane gas recovery and energy generation facility, a drop-off area for recyclables, a metal recovery facility, a wood and yard waste recovery and processing area, and a concrete recycling area.

There are approximately 28 residences scattered within a 2-mile radius of the landfill. The closest residence is located several hundred feet south of the landfill, on the south side of Road 29 south of the Willow Slough By-pass.

Groundwater levels at the facility fluctuate between 8 to 10 feet during the year, rising from lowest in the Fall to highest in the Spring. Water level data indicate that the water table level is typically 4 to 10 feet below ground surface during winter and spring months. During summer and fall months, the water table is typically 5 to 15 feet below ground surface. In January 1989, the County of Yolo constructed a soil/bentonite slurry cutoff wall to retard groundwater flow to the landfill site from the north. The cutoff wall was constructed along portions of the northern and western boundaries of the site to a maximum depth of 44 feet. The cutoff wall has a total length of 3,680 feet, 2,880 feet along the north side and 800 feet along the west. In the fall of 1990, irrigation practices to the north of the landfill site were altered to minimize the infiltration of water.

Additionally, sixteen groundwater extraction wells were installed south of the cutoff wall in order to lower the water table south and east of the wall, to provide vertical separation between the base of the landfill and groundwater.

Prior to placement of the slurry wall and dewatering system, the groundwater flow direction was generally to the southeast. Under current dewatering conditions, the apparent groundwater flow paths are towards the extraction wells located along the western portion of the northern site boundary. In essence, a capture zone is created by the cone of depression created by the ground water extraction system, minimizing the possibility of off-site migration of contamination.

3 NORTHEAST ANAEROBIC CELL

The northeast anaerobic cell occupies approximately 3.5 acres in the northeast quadrant of Phase 1, Module 6D.

3.1 Experimental

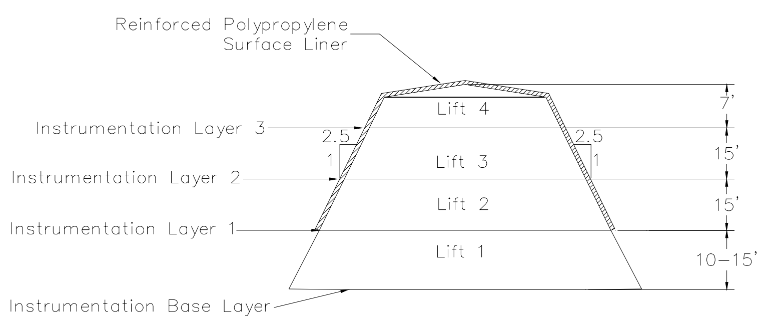
The experimental methods utilized are grouped into three categories: construction, monitoring, and operation. Each of these categories is discussed below.

3.1.1 Construction

Construction of the northeast 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 northeast anaerobic cell is provided in Appendix A, Table 3-1.

3.1.1.1 Waste Placement

Waste placement began on January 13, 2001 and was completed on August 3, 2001. Waste was placed in four separate lifts with an average thickness of 15 feet (Detail 3-1). In general, all waste received at the landfill was deposited in the northeast cell with the exception of self-haul waste. Because of the difficulties handling large volumes of self-haul vehicles in the limited area of the upper lifts, self-haul waste was not placed in lifts 3 and 4. 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. All side slopes were constructed at approximately 2.5 to 1 (horizontal to vertical) and received at least one foot of soil cover. Instrumentation Layers 1, 2, and 3 were placed between lifts, and base layer instrumentation was installed on the Module 6D base liner. A summary of sensors installed on each layer is provided in Appendix A, Table 3-2.



Detail 3-1. Northeast Anaerobic Cell Cross Section

3.1.1.2 Liquid Addition

Horizontal liquid injection lines were installed in each lift of waste (Image 3-1). Injection lines within the waste (between lifts 1 and 2, 2 and 3, 3 and 4) were placed approximately every 40 feet. Injection lines installed on top of lift 4 were installed every 25 feet, with an additional injection line following the perimeter of the top deck. Each injection line consists of a 1.25-inch-diameter high-density polyethylene (HDPE) pipe placed horizontally (north to south), which extends completely through the waste. Each injection line was perforated by drilling a $^{3}/_{32}$-inch hole every 20 feet. A total of 8,130 feet of injection piping was installed with a total of 342 injection holes.

Each of the injection laterals is connected to a 4-inch-diameter HDPE injection header. Individual solenoid valves are installed on each leachate injection lateral and connected to the Supervisory Control and Data Acquisition (SCADA) system used to monitor the various sensors and control the operation of the bioreactor. A flow meter monitors the total volume and injection flow rate for the entire northeast anaerobic cell.

Image 3-1. Horizontal LFG and leachate injection lines installed and being coverd by shredded tires.

3.1.1.3 Gas Collection

Horizontal landfill gas (LFG) collection lines were installed between each lift of waste (Image 3-1) and directly under the reinforced polypropylene (RPP) geomembrane cover. LFG collection lines consist of various combinations of alternating 4 and 6-inch–diameter, schedule 80 polyvinyl chloride (PVC) pipe (Image 3-2) as well as several variations using corrugated HDPE pipe. A summary of gas collection lines for the northeast anaerobic cell is provided in Appendix A, Table 3-3. At each line, shredded tires were used as the permeable media. The gas collection lines between layers are spaced approximately 40 feet apart and the lines directly under the RPP membrane are spaced at 25 feet. A total of sixteen LFG collection lines were installed.

Each LFG collection line is connected to a 6-inch-diameter LFG collection header that conveys the gas to the on-site LFG-to-energy facility. Each LFG collection line incorporates a pre-manufactured wellhead capable of controlling flow and monitoring flow rate, temperature and pressure.

Image 3-2. Horizontal LFG collection line

3.1.1.4 Surface Liner

The County retained the services of Vector Engineering (Vector) to design the surface membrane covers for each of the bioreactor cells (Image 3-3). Their scope of work included the following subtasks:

- Research the different commercially available membrane materials, including high and low density polyethylene, polyvinyl chloride, and reinforced polypropylene;
- Design of a biofilter to treat the off-gas from the aerobic cell;
- Prepare plans and specification for the installation of the surface liners; and
- Provide on-site construction quality assurance for the installation of the surface membrane.

Vector's scope of work was modified to include preparation of plans and specifications for the tie-in of the leachate injection and landfill gas collection piping.

Image 3-3. Northeast anaerobic surface liner

Based on Vector and County staff research, it was determined that a 36-mil reinforced polypropylene geomembrane (RPP) would be the preferred choice for an exposed geomembrane cover[1]. Reinforced polypropylene offered distinct advantages over the other potential materials including long service life (a 20-year warrantee was obtained), superior strength due to the nylon reinforcement, and low thermal expansion and contraction.

To expedite construction and reduce the overall cost of the project, the County decided to directly purchase the necessary membrane material and provide it to the contractor for installation. On June 29, 2001, the County issued a request for quotes for 350,000 square feet of 36-mil RPP. Quotes were received on July 9, 2001 with the lowest priced quote received from Colorado Linings International (Colorado).

The plans and specifications for the installation of the RPP surface liner were issued for bid on June 15, 2001. Later that month, Addendum Number 1 was issued to include a majority of the leachate injection and gas collection piping. Bids were due on July 13, 2001; however, no bids were received. The County inquired to each of the plan holders and generally found that bids were not submitted because the liner companies could not locate a subcontractor to perform the earthwork.

The County reissued the plans and specifications on July 23, 2001 and allowed three separate bid options. Option A was the entire project. Option B was only the installation of the liner, and Option C was only the earthwork. Bids were received on August 6, 2001 with the selected contractor being Colorado Linings International. Because Colorado's winning bid was significantly higher than the engineer's estimate and the potential difficulties with excessive pressure buildup under the aerobic liner, the covering of the aerobic cell was eliminated (for further discussion refer to Section 5.1).

The installation of surface liner and associated piping was completed in November 2001.

3.1.2 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 (Image 3-4). Temperature and moisture sensors are connected to the SCADA system used to monitor and control the operation of the bioreactor. Refer to Appendix B, Details 3-2 through 3-5 for sensor location diagrams.

[1] Vector Engineering, "Design Report for the Surface Liners of the Module D Phase 1 Bioreactors at the Yolo County Central Landfill", October 2001.

Image 3-4. Moisture, temperature , and tube installation

Sensors on instrumentation Layers 1, 2, and 3 were placed on either a bedding of greenwaste (shredded yard waste), wood chips (chipped wood waste), bin fines (fine pieces of greenwaste), or pea gravel to protect against damage from the underlying waste. Sensors installed on the primary liner (prior to any waste placement) were placed on geocomposite and covered with pea gravel prior to the placement of the chipped tire operations layer.

3.1.2.1 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.

3.1.2.2 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[2]. The PVC moisture sensor can provide a general, qualitative assessment of the waste's moisture content. A

[2] Yazdani, R., Moore, R. Dahl. K. and D. Augenstein 1998 Yolo County Controlled Landfill Bioreactor Project. Yolo County Public Works and I E M, Inc. Yolo County Public Works and I E M, Inc. report to the Urban Consortium Energy Foundation (UUCETF) and the Western Regional Biomass Energy Program, USDOE.

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.

The gypsum blocks are manufactured by Electronics Unlimited and are typically used for soil moisture determinations in agricultural applications. Gypsum blocks establish equilibrium with the media in which they are placed and are, therefore, reliable at tracking increases in the soil's moisture content. However, the gypsum block can take considerable time to dry and therefore may not reflect the drying of the surrounding environment.

3.1.2.3 Leachate Quantity and Quality

Leachate that is generated from the northeast anaerobic cell drains to the eastside Module D leachate collection sump (Image 3-5). 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. A digital flow meter will monitor the total volume and flow rate being injected in the cell. A manual meter has been installed to measure total volume in the event that the digital meter fails.

Leachate is monitored for the following field parameters: pH, electrical conductivity, dissolved oxygen, oxidation-reduction potential, and temperature. 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, monitoring will be conducted monthly during 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).

3.1.2.4 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.

3.1.2.5 Landfill Gas Composition and Flow

Landfill gas composition and flow are measured from the pre-manufactured well heads utilizing a GEM-500 combustible gas meter, manufactured by LANDTEC. 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.

Image 3-5. Gravel drainage layer and leachate collection sump

3.1.2.6 Surface Emissions

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) 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.

Methane emissions have been monitored with a TVA-1000 Flame Ionization Detector (FID)/Photo Ionization Detector (PID) or similar instrument rented from Total Safety Inc. Under the FID setting, the TVA -1000 measures total organic compounds (measured as methane) in air in the parts per million range. Prior to shipment, the TVA-1000 is calibrated by Total Safety to ensure correct operation. Due to the unavailability of the TVA-1000 instrument, an OVA-108 FID unit from Total Safety was used for the March 2003 surface scans. The OVA-108 has a slightly greater degree of accuracy (plus or minus 20 percent of reading) compared to the TVA-1000 which has a stated accuracy of plus or minus 25 percent of the reading or 2.5 parts per million (ppm), whichever is greater. The range of both meters is 1 to 10,000 ppm.

Image 3-6. Surface emission monitoring with the TVA 1000.

3.1.3 Operation

Operation of the northeast anaerobic cell as a bioreactor will began March 27, 2002 when supplemental liquid was first added to the cell.

3.1.3.1 Leachate Addition and Recirculation

Leachate addition to the northeast cell began on March 27, 2002 (Image 3-7). Each of the horizontal liquid injection lines was initially tested by pumping approximately 1000 gallons into the line to confirm operation and correlate flow versus pressure for each injection lateral.

Image 3-7. Leachate injection header and laterals

With the initial testing phase complete, full-scale liquid addition has commenced. Once the waste reaches field capacity, only enough liquid to maintain field capacity will be added.

During August 2002, leachate injection was temporarily halted due to scale buildup in the injection laterals which was significantly reducing the flow in the injection lines (Image 3-8). On September 11, 2002, approximately 3000 gallons of a citric acid solution (pH approximately 4) was added to the injection laterals on the northeast anaerobic cell to dissolve the scale buildup. The citric acid was added to the injection laterals and allowed to set overnight (approximately 14 hours). Groundwater was then flushed through the lines to remove the citric acid and scaling residue. Liquid injection resumed in the northeast cell on September 24, 2002.

Image 3-8. Scale buildup on the northeast 3.5-acre leachate injection lines.

Approximately 881,243 gallons of leachate recirculated through the end of September 2003 and 1,766,077 gallons of supplemental liquid has been added. Of the supplemental liquid added, 42 percent was added to Layer 1, 33 percent was added to Layer 2, 17 percent was added to Layer 3, and 8 percent was added to Layer 4 (Appendix C, Figure 3-1).

3.1.3.2 Landfill Gas Collection

Landfill gas collection began December 13, 2001 once the necessary piping was installed at the end of November 2001. Gas collection prior to leachate addition was necessary to prevent "billowing" or excess gas pressure under the surface liner.

3.2 Results And Discussion

Sensor names are represented numerically by the instrumentation layer in which the sensor is located, followed by the assigned sensor number. 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.

3.2.1 Temperature

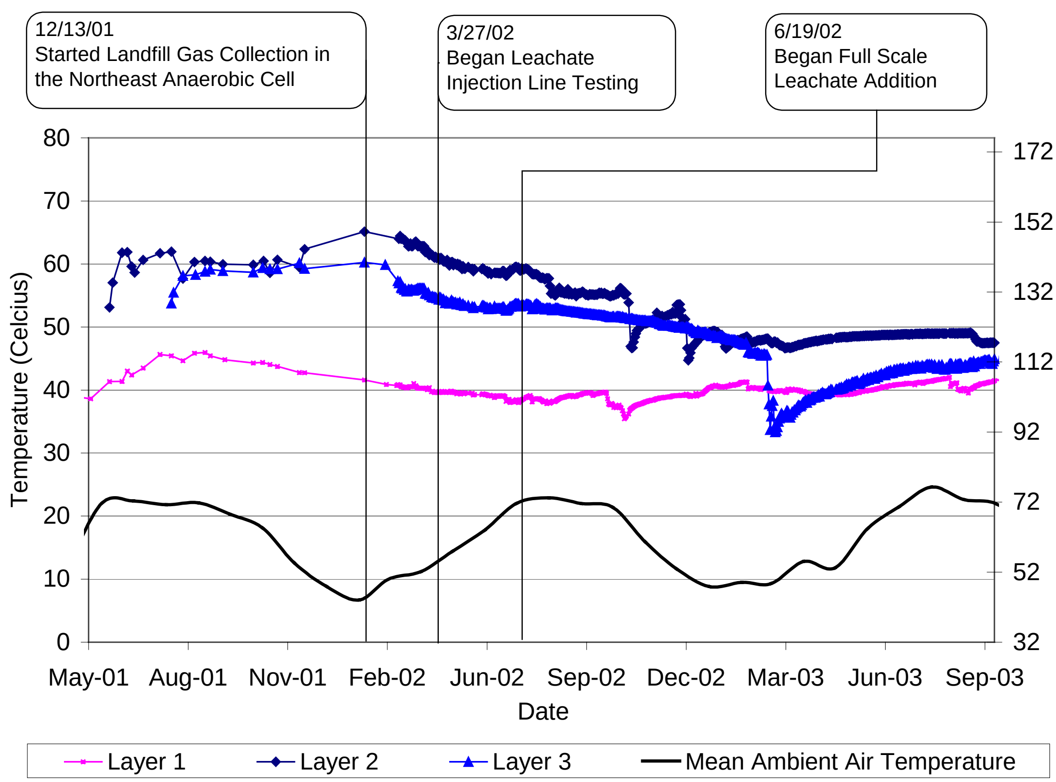
Temperature is monitored with thermistors manufactured by Quality Thermistor, Inc. Thermistors with a temperature range of 0°C to 100°C were chosen so they would be able to accommodate the temperature ranges expected in both the anaerobic and aerobic cells. Resistance was measured by the SCADA system located in the instrumentation shed starting in March 2002. Resistance was previously measured manually by connecting the sensor wires to a 26 III Multimeter manufactured by Fluke Corporation.

Temperature results are presented in Appendix C, Figures 3-2 to 3-4. Sensors show fluctuations in temperatures that correspond to the onset of leachate injection line testing and subsequent full-scale liquid addition. Representative sensors that demonstrate the cooling trend during liquid injection and subsequent warming trend following liquid injection are provided in Appendix C, Figure 3-5. A summary of the results is presented below in Table 3-4 and Figure 3-6.

Table 3-4. Temperature Summary for the Northeast Anaerobic Cell

	Previous Reporting Period (4/1/03 to 6/30/03)			Current Reporting Period (7/1/03 to 9/30/03)		
Layer	**Minimum Temp. (°C)**	**Maximum Temp. (°C)**	**Average Temp. (°C)**	**Minimum Temp. (°C)**	**Maximum Temp. (°C)**	**Average Temp. (°C)**
1	29.6	49.4	39.8	23.1	55.1	41.0
2	43.4	53.1	48.3	44.2	52.8	48.6
3	20.9	50.4	39.0	28.7	50.6	41.9

Figure 3-6. Average Temperatures for the Northeast Anaerobic Cell



3.2.2 Moisture

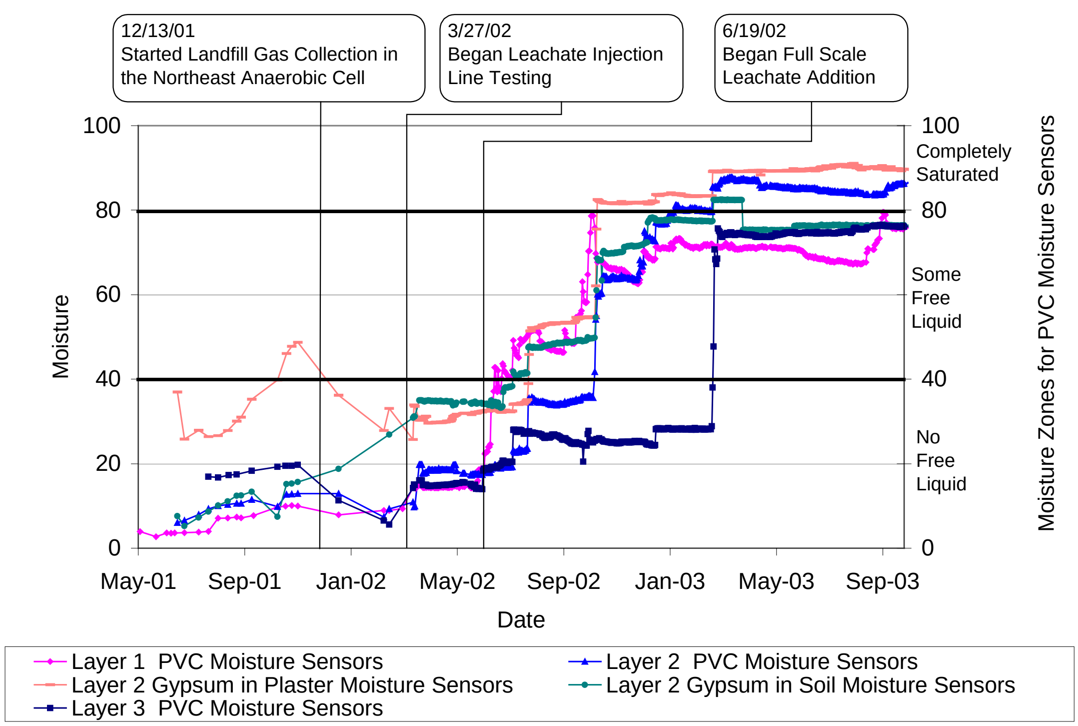
The SCADA system started electronically measuring moisture in March 2002. Moisture was previously measured manually with a Model MM 4 moisture meter manufactured by Electronics Unlimited. During the pilot scale project, Yolo County conducted laboratory tests with the PVC sensors to determine the relationship 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 3-7 to 3-11. Since the start of full-scale liquid addition in June 2002, the average moisture levels in Layer 1 and Layer 3 have increased to moisture levels in the some free liquid zone. Moisture levels in Layer 2 have also increased since the start of liquid addition with average moisture levels in the some free liquid zone and the completely saturated zone. A summary of the results is presented below in Table 3-5 and Figure 3-12.

Table 3-5. PVC Moisture Summary for the Northeast Anaerobic Cell

	Previous Reporting Period (04/01/03 to06/30/03)			Current Reporting Period (07/1/03 to 09/30/03)		
Layer	**Minimum Moisture**	**Maximum Moisture**	**Average Moisture**	**Minimum Moisture**	**Maximum Moisture**	**Average Moisture**
1	5.5	94.8	70.5	11.3	94.8	71.2
2	5.3	94.8	85.7	5.2	94.8	84.6
3	6.6	94.8	74.5	6.9	94.8	74.8

Figure 3-12. Average Moisture Levels for the Northeast Anaerobic Cell



3.2.3 Landfill Gas Collection System

Gas composition is measured from the wellheads located on top of the northeast anaerobic cell with the GEM-500. Gas flow is measured by differential pressures at the well heads with a DWYER Instruments, Inc., "Magnehelic" pressure gage. A thermal mass flow meter installed in the main header pipeline near the instrumentation shed records flow rate and total for all of the northeast cell. The meter is equipped with two separate calibration curves (for different gas constituent concentrations) and automatically corrects for temperature and pressure and records in standard cubic feet.

Gas collection lines are represented numerically by the layer the line is located, followed by a "G" and the number that denotes the line on a specific layer. For example, the first gas collection line on layer 3 is denoted 3-G1.

Landfill gas results are presented in Appendix C, Figures 3-13 to 3-15. Methane concentrations fluctuate based on the applied vacuum, barometric pressure, and the status of waste decomposition. In June 2002, the increase in oxygen and balance concentrations and the decline in methane and carbon dioxide concentrations can be attributed to the increase in vacuum applied to the gas collection system. In order to reduce landfill gas emissions while drilling for waste samples, the vacuum applied to the gas extraction system was increased resulting in air intrusion into the northeast anaerobic cell. A summary of the results is presented below in Table 3-6.

Table 3-6. Landfill Gas Summary for the Northeast Anaerobic Cell

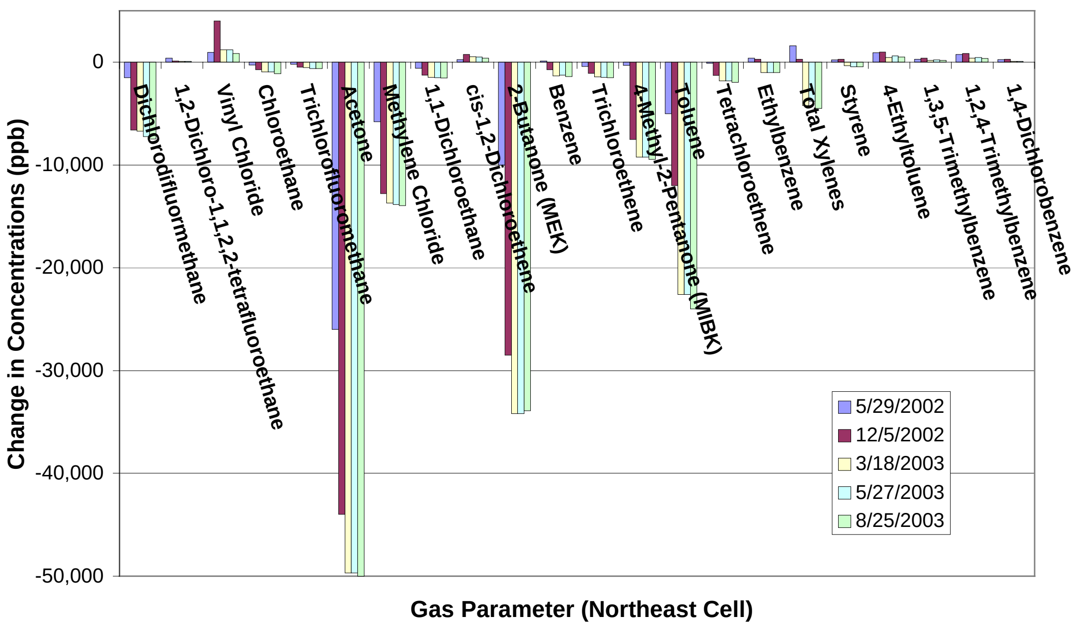
Parameter	**Results**		
Cumulative methane from December 16, 2001 to September 30, 2003	39.6×10^6 standard cubic feet (scf) (which is equivalent to approximately 6,285 barrels of oil)		
LFG flow rate for the period of July 1, 2003 through September 30, 2003	Minimum	Maximum	Average
	26.1 scf	195.6 scf	134.7 scf
Methane Concentration for the period of July 1, 2003 through September 30, 2003	Minimum	Maximum	Average
	39.3 %	58.8 %	48.3 %

Results indicate that the methane composition and the volume of landfill gas collected from the northeast anaerobic cell significantly increased following the beginning of full-scale liquid addition in June 2002. Through September 2003, the northeast anaerobic cell has generated approximately 0.32 cubic feet of methane per dry ton of waste. This number is used as a gage to determine the progress of decomposition and the values obtained can be utilized by other landfills to estimate landfill gas production. Comparing this to the estimated maximum methane potential of municipal solid waste of 1.8 cubic feet per pound, the northeast anaerobic cell has undergone 17.8 percent of its decomposition. In contrast, a typical "dry tomb" landfill of the same age (based on the EPA model, which does not account for supplemental liquid addition) would be expected to produce approximately 0.13 cubic feet per pound of dry waste.

Background samples of landfill gas were collected from the northeast anaerobic cell in March 2002 prior to liquid addition. Since March 2002, landfill gas has been sampled from the northeast 3.5-acre area on a quarterly basis. Analytical results are presented in Appendix D, Table 3-7.

Laboratory analysis of landfill gas samples collected from the northeast anaerobic cell indicates that most of the volatile organic compounds (VOC) constituents in the landfill gas have been reduced significantly as presented below in Figure 3-16. The total initial VOC concentration was reduced from 176,820 parts per billion (ppb) in March 2002 to only 26,294 ppb in August 2003. This represents an 85 percent decrease in total VOC concentration. Total VOC concentration was calculated by adding the individual concentrations of each VOC measured. We anticipate that most VOCs monitored in the landfill gas will eventually decrease over time following a similar trend to concentrations recorded in the pilot scale project. With the exception to vinyl chloride since it can only be degraded aerobically. Refer to Appendix D, Table 3-7 for a summary of the analytical results from the pilot scale project's enhanced cell.

Figure 3-16. Change in VOC Concentrations in LFG since March 2002.



3.2.4 Leachate Quantity And Quality

Initial leachate injection into the northeast cell began in March 2002 with an initial flush and subsequent pressure testing of each leachate injection lateral. Once the results from this initial test were analyzed and several minor repairs to the injection system were made full-scale liquid injection begin in June 2002. Initially, leachate was slowly added to the lower 15 feet of waste (lift 1) so that leachate buildup on the primary liner could be monitored to ensue that it did not exceed four inches. Once sufficient data had been collected to establish that liquid was not building up on the liner, leachate addition commenced to the remaining lifts of waste.

After July 24, 2002, all leachate generated was recirculated back to the northeast anaerobic cell with the exception of 35,460 gallons of leachate removed during injection line cleaning between September 24, 2002 and October 4, 2002. Approximately 1,766,077 gallons of supplemental liquid has been added and 881,243 gallons of leachate has been recirculated to the northeast anaerobic cell between June 2002 and September 2003 (Appendix C, Figure 3-1).

The average rate of liquid addition into the northeast cell has been approximately 1,050 gallons per day per acre with leachate recirculation averaging 500 gallons per day per acre. While at times the daily leachate addition rate was periodically higher (on the order of 12,000 gallons per day per acre) than the average, leachate seeps were not present because adequate time between injection cycles allowed leachate to soak in vertically rather than migrate horizontally.

Leachate was sampled for analytical testing on a monthly basis from May 2002 to October 2002 and thereafter was sampled on a quarterly basis. Analytical results are presented in Appendix E, Table 3-8. Field chemistry and selected analytical results are presented below in Table 3-9.

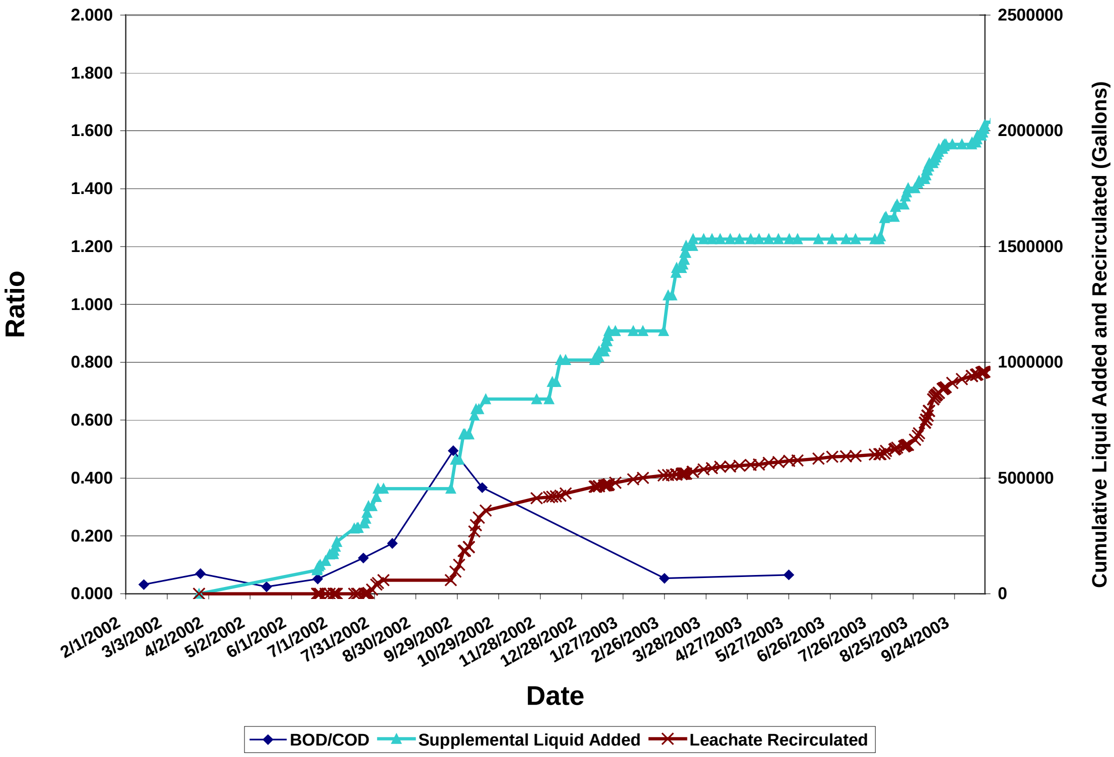
Table 3-9. Field Chemistry and Selected Laboratory Chemistry for Leachate Sampled from the Northeast Anaerobic Cell

PARAMETER	Date:	2/14/2002	5/14/2002	6/20/2002	7/23/2002	10/17/2002	2/26/2003	5/27/2003	8/21/2003
Field Parameters:	**Units**								
pH		7.13	7.40	7.60	7.44	7.35	8.16	7.02	7.55
Electrical Conductivity	µS	6583	6095	4054	11510	10230	9351	11990	10650
Oxidation Reduction Potential	mV	-119	80	94	-7	-25	160	17	34
Temperature	C	19.9	25.9	26.5	30.5	26.0	23.5	33.3	33.3
Dissolved Oxygen	mg/L	0.65	1.4	2.04	0.33	2.96	6	2.80	3.00
Total Dissolved Solids	ppm	5244	4059	3062	9740	8640	7850	9978	8673
General Chemistry:									
Bicarbonate Alkalinity	mg/L	1740	1760	1110	3740	4010	2680	3280	3220
Total Alkalinity as CO_3	mg/L	1740	1760	1110	3740	4010	2680	3280	3220
BOD	mg O/L	20	19	10	200	3000	44	85	66
Chemical Oxygen Demand	mg O/L	633	791	196	1620	1810	120	1590	1010
Chloride	mg/L	1070	1030	617	1950	1380	1470	1670	1650
Ammonia as N	mg/L	30	26.3	13.5	131	289	132	207	158
Nitrate-Nitrite as N	mg/L	<0.03	<1.5	<0.015	0.061	<0.009	NA	13	7.6
Total Kjeldahl Nitrogen	mg/L	53.1	40	21.8	201	358	222	320	271
Total Dissolved Solids @ 180 C	mg/L	4440	3700	2500	7800	6680	5720	7700	6430
Total (Non-Volatile) Organic Carbon	mg/L	202	123	68.8	544	588	325	490	286
Total Sulfide	mg/L	1.3	1.3	0.74	1.2	1.4	0.034 (tr)	0.020 (tr)	<0.0093
Dissolved Iron	mg/L	1.1	0.39	0.19	2.9*	4	2.5	2.8	2
Dissolved Magnesium	mg/L	323	262	NA	535	437	359	265	365
Dissolved Potassium	mg/L	152	133	NA	215	348	371	372	307

Leachate characteristics depend on the composition of waste, age of waste, rate and chemistry of water added, and the waste buffering capacity. The pH of leachate from the northeast cell has remained between 7.02 and 8.16 within the last year, which is considered in the optimum range. The optimum pH environment for methanogens is within the range of 7.5 to 8.5. The high pH source liquid added in this project is generally not typical of most landfills but is rather site specific to the Yolo County Landfill due to high pH of groundwater and the storage of leachate in evaporation ponds that tend to concentrate the alkalinity. At landfills with different source liquid characteristics, the pH of bioreactor leachate could be different.

The ratio of five-day biological oxygen demand (BOD_5) over chemical oxygen demand (COD) or BOD_5 over total organic carbon (TOC) is often used as a measure of leachate biodegradability[3]. Ratios of BOD_5/COD above 0.4 are generally considered as an indication that the organic matter in the leachate is readily degradable and ratios below 0.20 are generally associated with leachate from mature landfills and are indicative that the leachate is not readily biodegradable. The ratio of BOD/COD is presented in Figure 3-17 below.

Figure 3-17. BOD/COD over time for Leachate from the Northeast Anaerobic Cell



As presented in the figure above, the majority of the leachate from the northeast cell falls into the low biodegradability category with only the time period of mid September 2002 to February 2003 above a BOD_5/COD ratio of 0.40. Additionally, an anomaly exists for the October 17, 2002 sampling event wherein the BOD_5 value of 3,000 mg/L was higher than the COD value of 1810 mg/L. This is typically not possible, however the lab was contacted and reaffirmed these values. Because these values still remain suspect, this data was removed for the analysis.

The high biodegradability of the leachate between September 2002 to February 2003 was expected due to the initial flushing action of the injected liquid passing through relatively young waste. What was unexpected was the rapid decline and continued low BOD_5 values given the still early stages of bioreactor operation. Two possible explanations for this phenomenon are presented below.

[3] Tchobanoglous, G. and H. Theisen, S. Vigil, Integrated Solid Waste Management: Engineering Principle and Management Issues. Irwin/McGraw-Hill, New York, 1993 , pp 418-420.

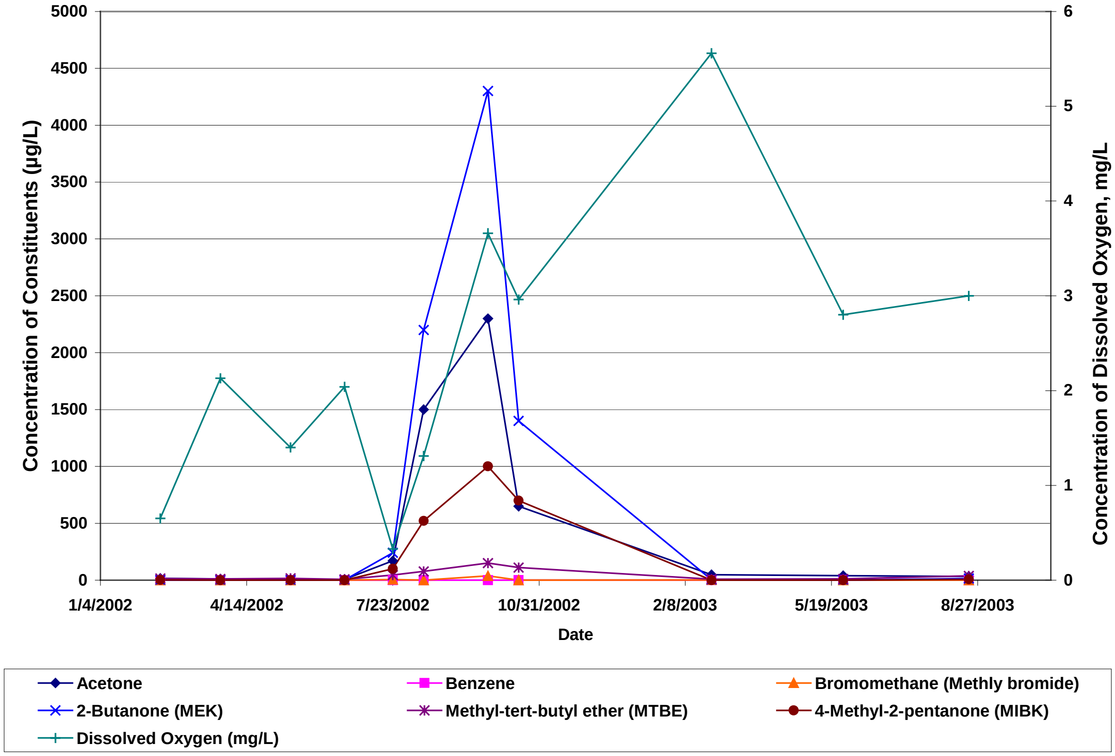
Once initial leachate recirculation commenced in the lowest lift in the cell (lift 1), a high level of anaerobic activity began creating an ideal environment for anaerobic bacteria to convert available biological material to methane. Then, as leachate addition and recirculation progressed to subsequent lifts of waste, the liquid that was injected in upper lifts had to percolate through lift 1 and the high degree of biological activity converted the readily available biological material in the leachate to methane.

The other possible explanation is that aerobic conditions present in the Module D leachate collection and removal system (LCRS), where leachate samples were collected, oxidized the readily available biological portion of the leachate, thus lowering the BOD_5 levels. Through the majority of the project, landfill gas was not collected from the LCRS but was rather only collected from the gas wells installed in the northeast 3.5-acre cell. To collect landfill gas from the cell it was necessary to apply a vacuum to these wells but it was this same vacuum that created a pressure gradient whereby air would have a tendency to pass into the cell. Because the surface cover system is virtually impermeable (see surface monitoring results in section 3.2.5), the only way for any air to enter the cell would be through the permeable LCRS system. Analysis of the gas in the permeable LCRS layer indicated that there was oxygen present in this layer. Given enough contact time, it is possible that this oxygen could react with the leachate and lower the BOD_5 level. It is possible that the high BOD_5 levels recorded between September 2002 to February 2003 were not affected by oxygen in the LCRS layer because flows were sufficiently high to limit the contact time, however subsequent results were affected because leachate outflows were low enough to allow significant contact time.

The build up of ammonia in leachate as recirculation continues over time can eventually be toxic anaerobic decomposition. Results from the pilot-scale project at the Yolo County Landfill indicated active methanogenic activity with ammonia levels ranging between approximately 300 and 600 parts per million (ppm). Levels of ammonia that may typically be considered toxic to methanogenic bacteria may actually be tolerated because of the bacteria's ability it to acclimatize itself. Studies have shown methanogenic bacteria can tolerate ammonia levels in the ranges of 1500 to 3000 ppm. Because ammonia buildup in recirculated leachate can be a concern, it may be necessary to eventually treat the leachate or flush the cell with fresh liquid in order to minimize this phenomenon. Refer to Table 3-9 above for a summary of the ammonia results.

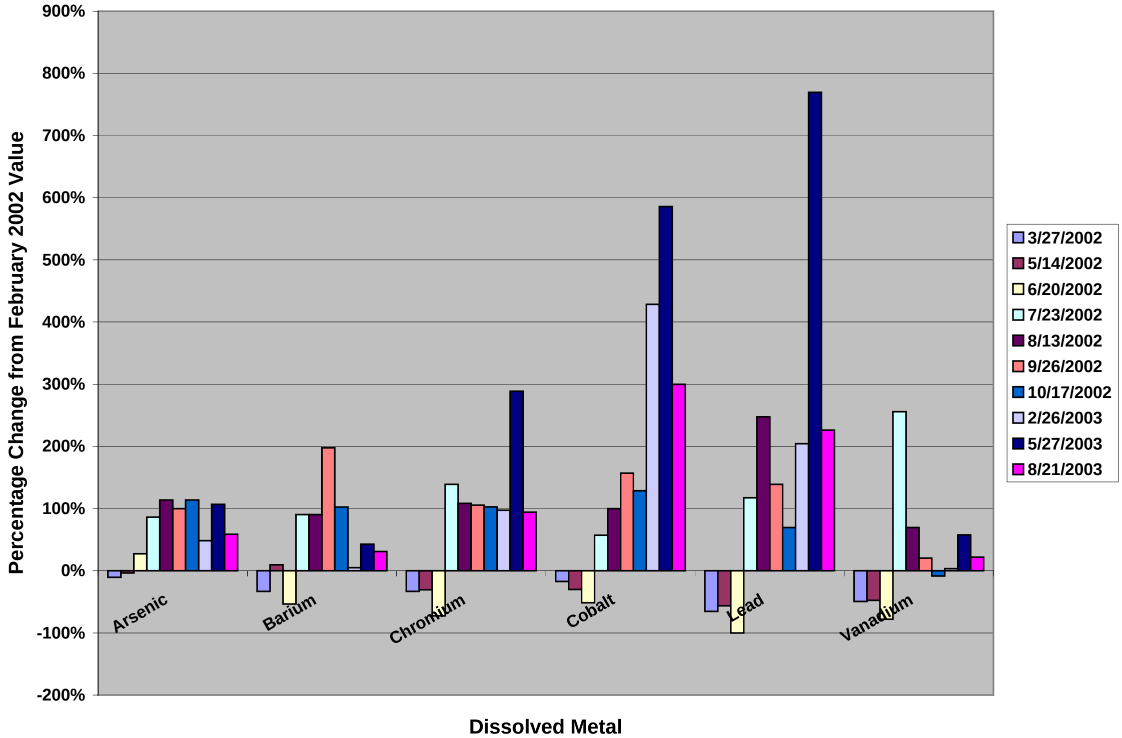
Trace volatile organic compound (VOC) concentrations are presented in Figure 3-18 below. VOC levels in the northeast cell leachate follow a similar trend to BOD_5 with initial levels being low, then rising to a peak in October 2002 and then falling again as leachate recirculation continued. It is possible that the same phenomenon affecting the BOD_5 levels could also be affecting the VOC levels. Further data will be required to confirm if VOC levels truly declined because of bioreactor operation or simply were volatilized in the LCRS layer.

Figure 3-18. Concentration of various VOC's over time for Leachate from the Northeast Anaerobic Cell



As bioreactor operation continues, the concentration of dissolved metals in the leachate is expected to reduce because as recirculation continues, dissolved metals have a tendency to precipitate out as pH increases. Figure 3-19 below presents the percentage change in dissolved metal concentration from the initial February 2002 samples for several important constituents. As presented in the graph, each of these metals showed a decrease in concentration over the first several sampling events, then as injected water percolated through the waste and reached the LCRS system, each of the constituents increased in concentration. In addition to the potential water quality impacts of high dissolved metals concentrations, dissolved metals can also be toxic to bacteria growth and retard landfill gas production. Further data will be required to demonstrate if dissolved metals reduce in concentration, continue to remain above baseline levels, or rise in concentration.

Figure 3-19. Change in dissolved metals concentration relative to initial concentration measured in February 2002 for Leachate from the Northeast Anaerobic Cell



3.2.5 Surface Emissions

Methane surface concentrations are monitored along the perimeter of the collection area and along a pattern that transverses the landfill at 15 meter intervals. Surface emissions have generally been monitored on a quarterly basis since April 2002. 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 northeast anaerobic cell is presented below in Table 3-10. As presented in this table, the highest single emission detected from this cell was 10 ppm and the highest average emission detected was 1.1 ppm. Average emissions were calculated by taking a weighted average of emissions detected along the entire scan. For example, if the entire traverse of the surface scan were 1000 meters and surface emissions of 100 ppm were detected along 200 meters of that traverse, the average surface emission would be (average emission) = (800meters*0ppm + 200 meters*100ppm)/1000meters = 20ppm.

Table 3-10. Summary of Surface Scans Performed on the Northeast Anaerobic Cell

Date	Time Period	Average Emissions Detected*	Max. Emissions Detected	Location Of Maximum Emissions	Average Vacuum Applied by LFG Extraction System
04/03/02	Before liquid addition	0 ppm	0 ppm	Not applicable	-0.10 Inches H_2O
06/06/02	After liquid addition	1.1 ppm	9 ppm	Southwest corner of the cell	-0.54 Inches H_2O
09/19/02		0.25 ppm	8 ppm	Northwest corner of the cell	-0.54 Inches H_2O
01/07/03		0 ppm	0 ppm	Not applicable	-7.5 Inches H_2O
03/19/03		0.18 ppm	10 ppm	Along the entire northern perimeter of the cell.	-14.5 Inches H_2O
04/15/03		0.08	6.7 ppm	At one location on the west face of the cell, approximately 15 meters from the west perimeter and 43 meters from the south perimeter.	-7.5 Inches H_2O
09/29/03		0 ppm	0 ppm	Not applicable	-15.9 Inches H_2O

*Based on the weighted average of emissions detected along the entire traverse.

The few detected surface emissions in the northeast anaerobic cell were most likely due to landfill operations in nearby areas. Changes in wind currents during the surface scan could have transported methane from adjacent areas and resulted in the detection of surface emissions that were not detected in background measurements. The detection of surface emissions in June and September 2002 may have been due to emissions from waste placement activities in the west-side anaerobic cell or from construction activities in Module D Phase II construction, which involved exposing waste from an adjacent unit to facilitate base liner installation. Methane surface emissions detected in March and April 2003 can be attributed to background emissions detected on the west-side anaerobic cell area (refer to section 4.2.5).

Visual observations of the northeast anaerobic cell's surface liner and calculations as to the pressure necessary to lift that liner confirm the low surface emissions detected. Several times within the last year the landfill gas (LFG)- to-energy facility was shutdown, either for maintenance or mechanical failure which resulted in some moderate "ballooning" of the surface cover. However, during normal operation of the gas collection system, no "ballooning" was observed. Calculations based on the weight of the sandbags and liner material indicate that only an extremely low positive pressure on the order of 0.20 inches of water (0.007 psi) is necessary to lift the cover. Because only a small amount of pressure is necessary to lift the liner, the observation that the liner is being held tightly to the surface (even on windy days where aerodynamic uplift would have a tendency to lift the liner) of the module would confirm that a pressure gradient exists such that gas would have a tendency to pass from the outside into the cell.

The only current regulatory guideline for comparing the surface emissions from the bioreactor are found in 40 CFR 60, Subpart WWW, Standards of Performance for Municipal Solid Waste Landfills. Specifically, 40 CFR 60.755 requires landfills over a certain size to maintain surface methane emissions below 500 ppm. Comparing the readings obtained from the northeast anaerobic cell to the regulatory threshold of 500 ppm it is evident that the overall surface emissions from the cell are extremely low.

3.2.6 Waste Sampling

Yolo County conducted the second waste sampling event for the bioreactor project on July 15 and 16, 2003 (Images 3-9 and 3-11). In each of the bioreactor cells, two boreholes were drilled with a 24-inch diameter solid stem auger and samples were collected at approximately 5-foot intervals. These samples were then sent to North Carolina State University where they were analyzed to quantify the amount of decomposition that is possible under anaerobic conditions. Results will be available in the coming year.

Image 3-9. An excavator-mounted drill rig was used for the sampling event to drill boreholes 25 to 40 feet deep.

Image 3-10. Excavated waste was placed on liner material located adjacent to the boreholes where samples were then collected.

Image 3-11. At select locations, samples were collected directly from the auger to record the temperature of the waste as it was removed from the cell.

Results from the first round of sampling in June 2002 indicate that the biochemical methane potential (BMP) of samples collected from the northeast anaerobic cell is approximately 53.49 ml/gram (0.86 cubic feet per pound). The results from this sampling event appear unusually low given the generally accepted methane potential of waste between 1.5 and 1.8 cubic feet per pound. It is possible that the low methane potential of the waste collected from this sampling event is not representative of the actual methane potential of the waste in the cell. As additional data is collected during subsequent sampling events, comparisons between theoretical methane potential and actual measured methane generation will allow further evaluation of the data.

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

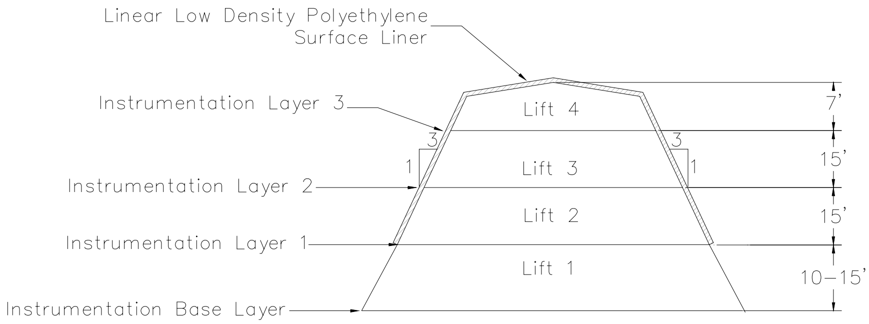
The experimental methods utilized are grouped into three categories: construction, monitoring, and operation. Each of these categories is discussed below.

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 $^1/_8$ or $^3/_{32}$-inch holes 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 is connected to a 4-inch-diameter HDPE injection header. Leachate injection for each lateral is manually controlled and monitored by individual valves and flow meters (Image 4-2). A manual flow meter monitors the total volume and injection flow rate for the entire west-side anaerobic cell.

Image 4-2. Installation of valve and flow meter assembly on leachate injection lines

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 west-side 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 (Image 4-3). Each LFG collection line incorporates a valve capable of controlling flow and a port for monitoring gas composition, temperature, pressure, and flow rate.

Image 4-3. LFG collection laterals connected to the main header line located on top the cell.

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 4-4).

Image 4-4. 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. Temperature and moisture sensors are connected to the Supervisory Control and Data Acquisition (SCADA) system used for monitoring and controlling the operation of the bioreactor. 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 Surface Emissions
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.

Methane emissions have been monitored with a TVA-1000 Flame Ionization Detector (FID)/Photo Ionization Detector (PID) or similar instrument rented from Total Safety Inc. Under the FID setting, the TVA -1000 measures total organic compounds (measured as methane) in air in the parts per million range. Prior to shipment, the TVA-1000 is calibrated by Total Safety to ensure correct operation. Due to the unavailability of the TVA-1000 instrument, an OVA-108 FID unit from Total Safety was used for the March 2003 surface scans. The OVA-108 has a slightly greater degree of accuracy (plus or minus 20 percent of reading) compared to the TVA-1000 which has a stated accuracy of plus or minus 25 percent of the reading or 2.5 parts per million (ppm), whichever is greater. The range of both meters is 1 to 10,000 ppm.

4.1.3 Operation
Operation of the west-side anaerobic began once the leachate recirculation system was completed in June 2003.

4.1.3.1 Leachate Addition and Recirculation
Prior to the start of leachate addition, the west-side anaerobic cell leachate injection header line and laterals were flushed with groundwater to any residue or debris from construction activities (Image 4-5).

Full-scale leachate addition began on June 5, 2003. Through the end of September 2003, a total of 1,900,625 gallons of supplemental liquid was added and 3,600 gallons of leachate recirculated into Layers 3 and 4 of the west 6-acre area (Appendix C, Figure 4-1).

In comparison to the northeast anaerobic cell, the west-side anaerobic cell has operated at higher daily injection rates which as resulted in several leachate seeps along the western slope of the cell.

Though no seeps were visible because of the geomembrane covering the cell, a sufficient quantity of leachate did break through the side slope of the cell. The leachate traveled down the geomembrane liner to create a pool of liquid at the toe of the cell under the liner. This leachate buildup was evident by walking on the liner and feeling a "waterbed" effect. To mitigate this condition, leachate addition was halted and the liner was cut so that a pump could be inserted to remove the accumulated leachate. The liner was then cut and removed along the toe of the cell and a gravel and shredded tire trench was installed so that any future leachate would drain vertically to the underlying LCRS. Once the liner is repaired, which is scheduled for December 2003, leachate addition to the west-side anaerobic cell will continue (at a lower rate) in layer 3.

4.1.3.2 Landfill Gas Collection

Landfill gas collection began May 7, 2002 from the leachate collection and removal system (LCRS). Gas collection from the horizontal gas collection piping installed in the waste began on March 13, 2003.

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

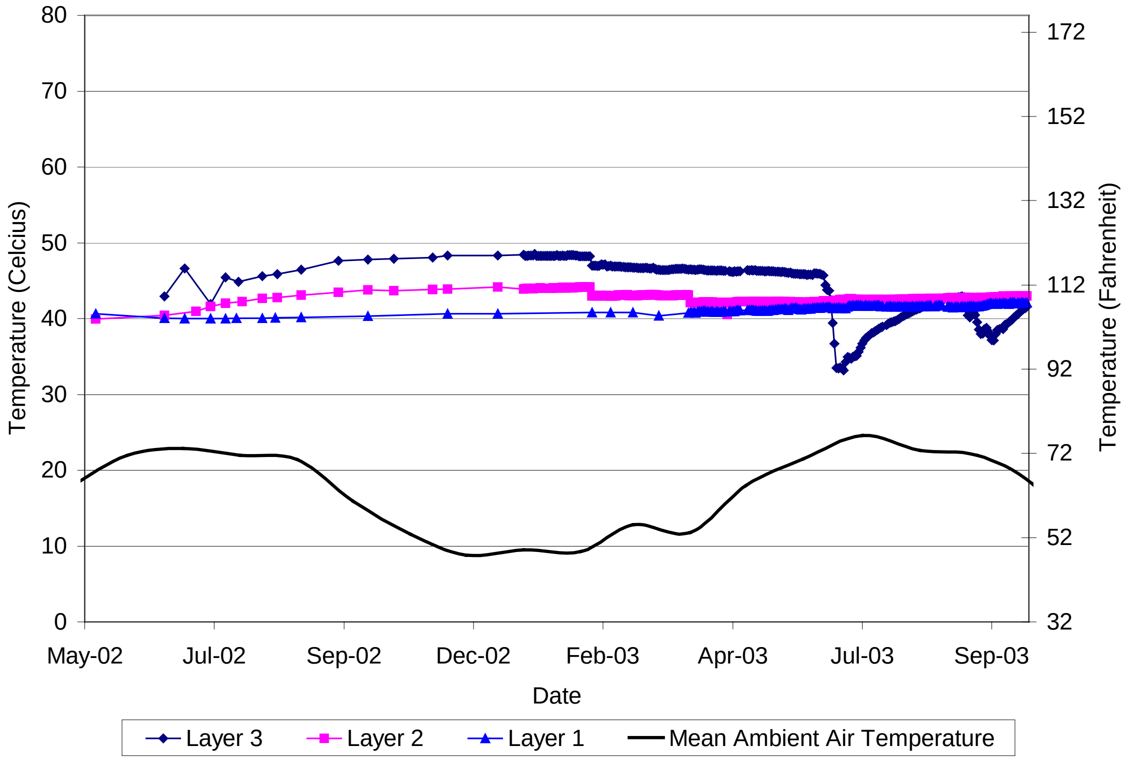
Temperature is monitored with thermistors manufactured by Quality Thermistor, Inc. Thermistors with a temperature range of 0°C to 100°C were chosen so they would be able to accommodate the temperature ranges expected in both the anaerobic and aerobic cells. Resistance was measured by the SCADA system located in the instrumentation shed starting in January 2003. Resistance was previously measured manually by connecting the sensor wires to a 26 III Multimeter manufactured by Fluke Corporation.

Temperature results are presented in Appendix C, Figures 4-2 to 4-4. Since the start of liquid addition in June 2003, the average temperature on Layer 3 has dropped approximately 4 degrees Celsius. As in the northeast anaerobic cell, Layer 3 sensors show a cooling trend during liquid injection and subsequent warming trend following liquid injection. Liquid addition has not commenced on Layer 2 and average temperatures generally remain stable. Liquid injection piping was not installed on Layer 1 but we expect to see changes in temperatures as liquid percolates down from the upper lifts. A summary of the results is presented below in Table 4-3 and Figure 4-5.

Table 4-3. Temperature Summary for the West-Side Anaerobic Cell

	Previous Reporting Period (04/01/03 to 06/30/03)			Current Reporting Period (07/01/03 to 09/30/03)		
Layer	Minimum Temp. (°C)	Maximum Temp. (°C)	Average Temp. (°C)	Minimum Temp. (°C)	Maximum Temp. (°C)	Average Temp. (°C)
1	37.6	45.9	41.2	37.5	47.4	41.7
2	8.6	49.3	43.5	8.6	51.8	42.7
3	24.1	52.5	44.2	28.2	50.3	40.1

Figure 4-5. Average Temperatures for the West-Side Anaerobic Cell



4.2.2 Moisture

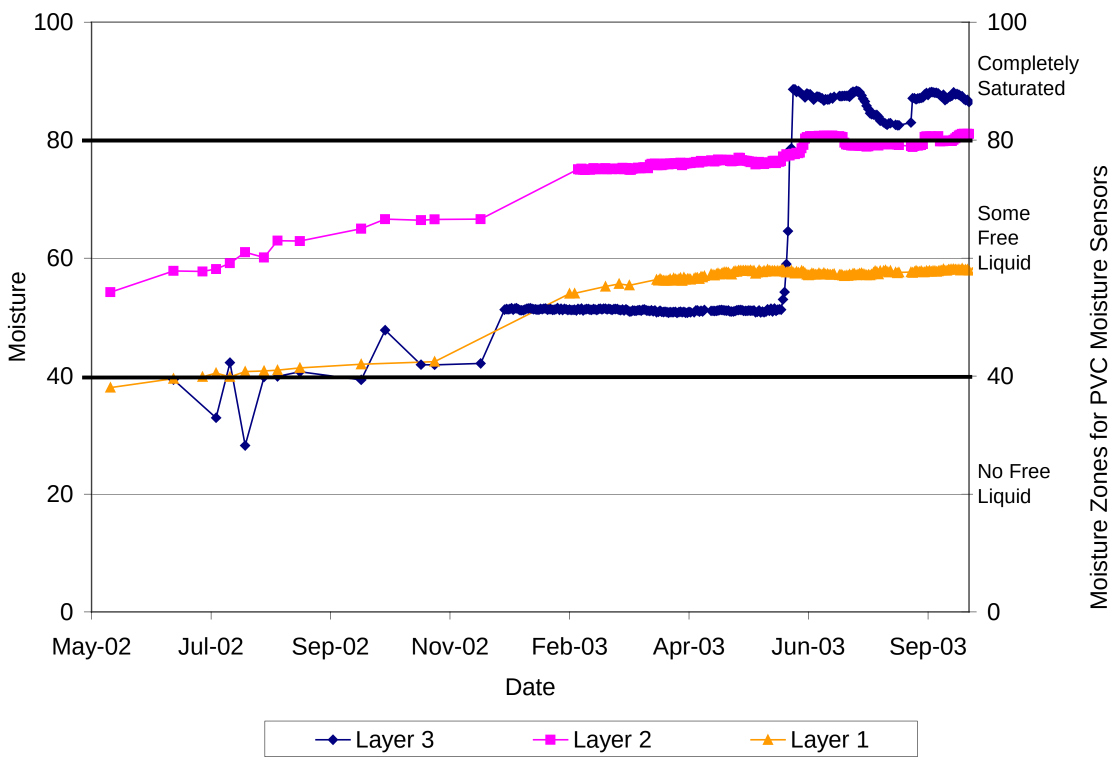
The SCADA system started electronically measuring moisture in January 2003. Moisture was previously measured manually with a Model MM 4 moisture meter manufactured by Electronics Unlimited. Moisture data are unitless numbers that give a qualitative assessment rather than a quantitative measure. During 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 4-6 to 4-8. Due to the start of liquid addition in June 2003, the average moisture levels in Layer 3 increased from the some free liquid zone to the completely saturated zone. Likewise, the average moisture levels in Layer 2 have steadily increased to the cusp between the some free liquid zone and no free liquid zone. We expect to see the moisture levels in Layer 1 increase as liquid is added to the upper lifts of waste. A summary of the results is presented below in Table 4-4 and Figure 4-9.

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

	Previous Reporting Period (04/1/03 to 06/30/03)			Current Reporting Period (07/1/03 to 09/30/03)		
Layer	Minimum Moisture	Maximum Moisture	Average Moisture	Minimum Moisture	Maximum Moisture	Average Moisture
1	38.2	39.9	57.3	38.6	40.4	57.6
2	2.9	94.8	76.7	2.7	94.8	79.7
3	4.4	94.8	57.0	43.4	94.8	86.3

Figure 4-9. 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 pressure utilizing a 1/8-inch diameter pitot tube by DWYER Instruments, Inc., in combination with the GEM-500. A thermal mass flow meter was 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 4-10 and 4-11. Methane concentrations from the wellhead fluctuate based on the applied vacuum, barometric pressure, and the status of waste decomposition. Results indicate that landfill gas flow rate and methane composition increased following surface liner installation in October 2003 and increased again following liquid addition in June 2003. A summary of the current results is presented below in Table 4-5.

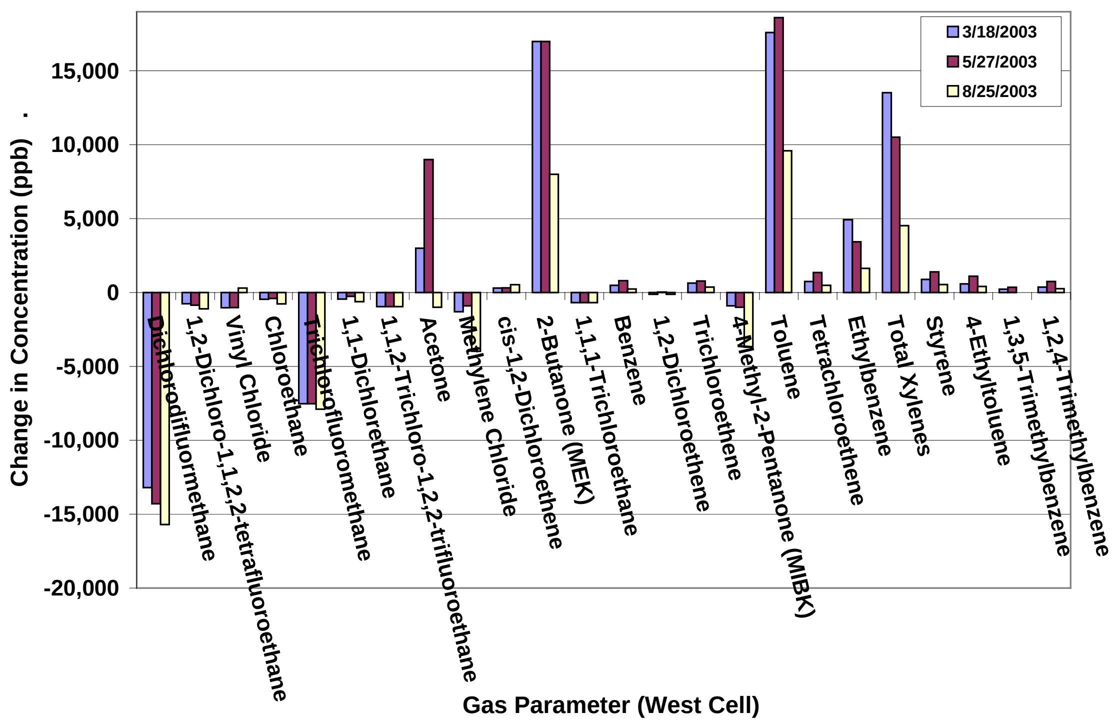
Table 4-5. Landfill Gas Summary for the West-Side Anaerobic Cell.

Parameter	Results		
Cumulative Methane from May 7, 2002 to September 30, 2003	15.7 x 10^6 standard cubic feet (scf) (which is equivalent to approximately 2,492 barrels of oil)		
LFG Flow Rate for the period of July 1, 2003 to September 30, 2003	Minimum	Maximum	Average
	60.0 scf	200.0 scf	142.2 scf
Methane Concentration for the period of July 1, 2003 to September 30, 2003	Minimum	Maximum	Average
	36.5 %	57.6 %	48.2%

Through September 2003, the west-side anaerobic cell has generated approximately 0.053 cubic feet of methane per dry ton of waste, as presented in Appendix A, Figure 3-15. This number is used as a gage to determine the progress of decomposition and the values obtained can be utilized by other landfills to estimate landfill gas production. Comparing this to the estimated maximum methane potential of municipal solid waste of 1.8 cubic feet per pound, the west-side anaerobic cell has undergone 2.9 percent of its decomposition. Because the gas production from the west-side anaerobic cell is still in its initial stages, the gas production curve closely resembles that of a "dry tomb" landfill, in the future we expect the gas production from the west-side anaerobic cell to mimic the northeast anaerobic cell.

Background samples of landfill gas were collected from the anaerobic area in May 2002 and March 2003 prior to liquid addition. Since March 2003, landfill gas has been sampled from the west 6-acre area on a quarterly basis. Analytical results are presented in Appendix D. No definitive trends can be concluded form the laboratory analysis of landfill gas samples collected from the west-side anaerobic cell because only 4 samples have been analyzed to date. Figure 4-12 presents the change in VOC constituent concentrations relative to the May 2002 sampling event. As presented in this graph, some constituents have increased while others have decreased. Once additional sampling has been completed we expect a trend in decreasing VOC constituents over time similar to the northeast anaerobic cell.

Figure 4-12. Change in VOC Concentrations in LFG since May 2002.



4.2.4 Leachate Quantity And Quality

Full-scale leachate addition began on June 5, 2003 and all leachate generated after this date was recirculated back into the west-side anaerobic cell. Approximately 1,900,625 gallons of supplemental liquid was added and 3,600 gallons of leachate recirculated into Layers 3 and 4 of the west-side anaerobic cell from June 2003 through September 2003 (Appendix C, Figure 4-1).

The average rate of liquid addition into the west-side anaerobic cell has been approximately 2,500 gallons per day per acre with leachate recirculation averaging 6 gallons per day per acre. Compared to the northeast cell, the liquid addition rate was approximately 2.4 times greater into the west-side cell. The higher injection rate into the west-side cell resulted in leachate seeps along the western side slope of the cell. To mitigate the condition, a gravel and shredded tire trench was installed at the toe of the slope so that any future liquid would drain back to the LCRS (refer to section 4.1.3.1).

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.

Table 4-8. Field Chemistry and Selected Laboratory Chemistry for Leachate Sampled from the West-Side Anaerobic Cell

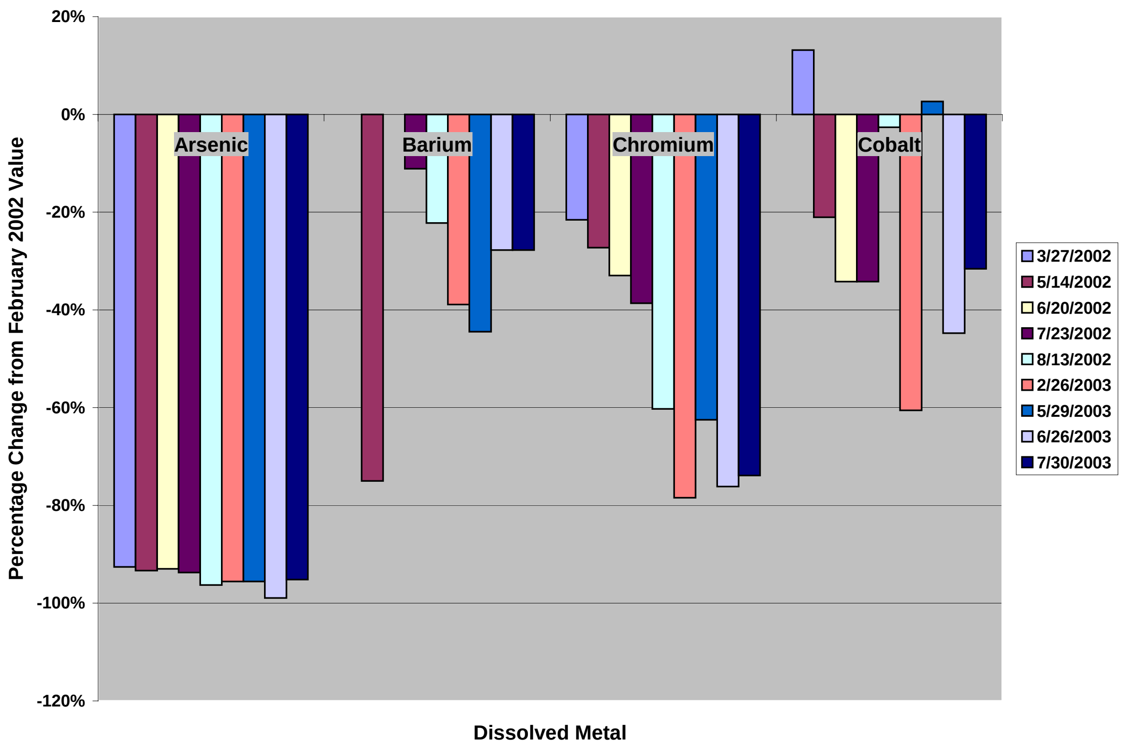
PARAMETER	DATE:	2/14/2002	5/14/2002	6/20/2002	7/23/2002	2/26/2003	5/29/2003	6/26/2003	7/30/2003
Field Parameters:	**Units**								
pH		6.74	6.8	6.72	6.85	6.87	6.72	6.66	6.63
Electrical Conductivity	µS	3530	3851	3944	3899	2320	2687	3056	3265
Oxidation Reduction Potential	mV	-62	-46	-19	-38	-56	-33	-75	-55
Temperature	C	24.9	26.2	25.2	25.7	22.1	29.3	30.4	28.5
Dissolved Oxygen	mg/L	3.15	1.54	1.31	3.62	3.18	1.06	1.55	1.61
Total Dissolved Solids	ppm	2617	2871	2960	2965	1703	1933	2227	2398
General Chemistry:									
Bicarbonate Alkalinity	mg/L	1700	1780	1730	1710	1000	1070	1210	1260
Total Alkalinity as CO_3	mg/L	1700	1780	1730	1710	1000	1070	1210	1260
BOD	mg O/L	28	12	12	7.9	16	11	<6.0	10
Chemical Oxygen Demand	mg O/L	350	300	274	270	98.1	82.5	102	105
Chloride	mg/L	187	333	358	341	196	263	345	335
Ammonia as N	mg/L	20.3	23.5	21.2	23.8	9.5	10.3	13.7	12.4
Nitrate-Nitrite as N	mg/L	0.016(tr)	<1.5	<0.03	<0.015	0.022 (tr)	<0.18	<0.09	<0.25
Total Kjeldahl Nitrogen	mg/L	32.6	31.1	31.5	31.4	13.8	15.7	19.1	15.7*
Total Dissolved Solids @ 180 C	mg/L	2220	2320	2410	2310	1320	1480	1700	1840
Total (Non-Volatile) Organic Carbon	mg/L	112	85.2	86.5	82.7	28.3	25.5	37.9	34.4
Total Sulfide	mg/L	0.033(tr)	<0.014	<0.014	0.023 (tr)	<0.0093	<0.0093	<0.0093	<0.0093
Dissolved Iron	mg/L	0.4	0.035(tr)*	1.9	0.59	0.15	0.11	0.064 (tr)	0.077 (tr)
Dissolved Magnesium	mg/L	198	343	NA	217	123	143	162	173
Dissolved Potassium	mg/L	55.2	58.6	NA	37.8	23.7	20.1	23.8	22.8

To date, BOD_5 and COD levels remain low in the west-side cell compared to the northeast cell with all BOD_5/COD ratios remaining below 0.20. Once sufficient leachate is generated from the west-side anaerobic cell, additional data will be collected and a more thorough analysis of the leachate biodegradability will be possible.

Because very little leachate has been recirculated in the west-side anaerobic cell, ammonia buildup is not expected yet and collected data confirms this with no ammonia levels above 30ppm (Refer to Table 4-7 above for a summary of the results).

Figure 4-13 below presents the percentage change in dissolved metal concentration from the initial February 2002 samples for several important constituents (other constituents were omitted from the graph because of extremely low or non-detect levels). As presented in the graph, each of these metals showed a decrease in concentration over the first sampling event. This pattern is similar to that observed in the northeast anaerobic cell prior to significant leachate being generated by the cell. We anticipate that as leachate generation increases, a spike in dissolved metals will occur similar to that observed in the northeast cell.

Figure 4-13 Change in dissolved metals concentration relative to initial concentration measured in February 2002 for Leachate from the West-Side Anaerobic Cell



4.2.5 Surface Emissions

Methane surface concentrations are monitored along the perimeter of the collection area and along a pattern that transverses the landfill at 15 meter intervals. Surface emissions have generally been monitored on a quarterly basis since April 2002. 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 4-9. Average emissions were calculated by taking a weighted average of emissions detected along the entire scan. For example, if the entire traverse of the surface scan were 1000 meters and surface emissions of 100 ppm were detected along 200 meters of that traverse, the average surface emission would be (average emission) = (800meters*0ppm + 200 meters*100ppm)/1000meters = 20ppm.

Table 4-9. Summary of Surface Scans Performed on the West-Side Anaerobic Cell

Date Performed	Time Period	Average Emissions Detected*	Max. Emissions Detected	Location Of Maximum Emissions	Average Vacuum Applied by LFG Extraction System
04/03/02	Before cover system	0.84	50 ppm	Southwest corner of the cell	No vacuum applied.
06/06/02		6.5 ppm	37 ppm	On top the cell, along the access road leading to the active waste placement area	-0.08 Inches H2O
09/19/02		4.2 ppm	124 ppm	Southwest corner of the cell. This area was rescanned and surface concentrations decreased to approximately 10 ppm.	-0.36 Inches H2O
01/08/03	Cover system installed, before liquid addition	0.70 ppm	30 ppm	Along the northern perimeter near piping from the leachate collection and removal system (LCRS).	-3.2 Inches H2O
03/19/03		5.8 ppm	85 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 meters east of the LCRS piping, and (3) directly south of the top deck hinge point and approximately 15 meters west of the centerline of the cell.	-0.55 Inches H2O
04/15/03		2.1 ppm	126 ppm	Detected at one location on the east face of the cell, approximately 75 meters from the south toe and 30 meters from the eastern perimeter of the cell near where piping exits the cell.	-1.05 Inches H2O
09/29/03	After liquid addition	0.64 ppm	59.3 ppm	At one location on the east face of the cell approximately 49 feet from the eastern perimeter and 200 feet from the southern perimeter.	-1.98 Inches H2O

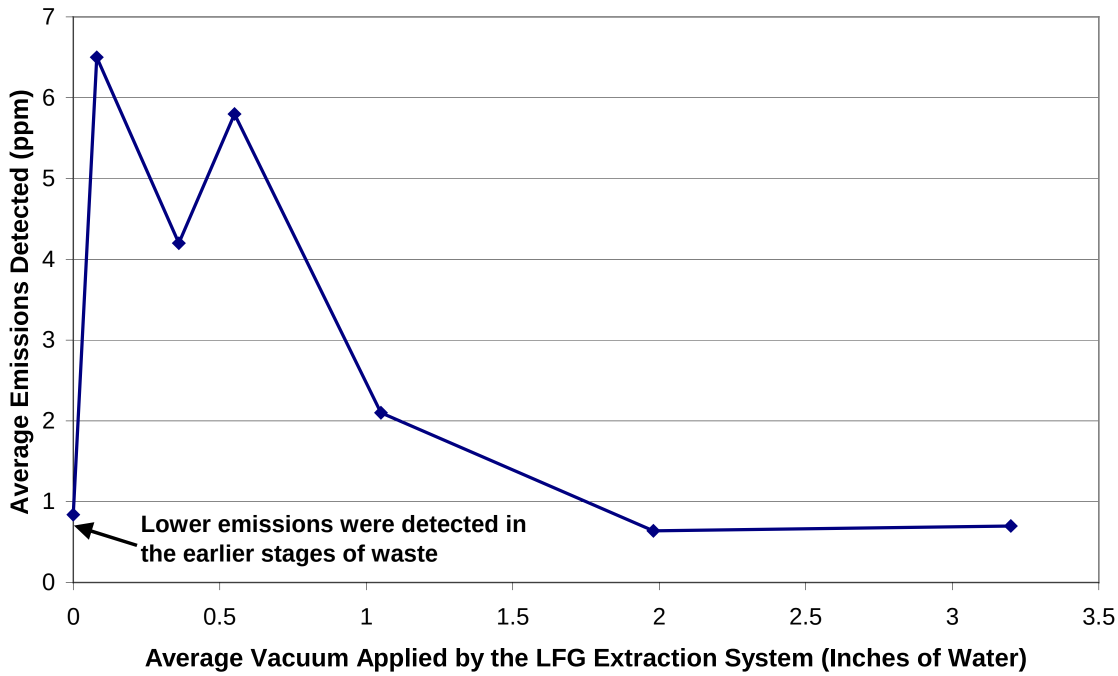
*Based on the weighted average of emissions detected along the entire traverse.

As presented in above in Table 4-8, higher emissions have been detected on the west-side anaerobic cell. In April 2002, higher emissions were detected because the west cell was still under construction and a surface cover system had not been installed. In June 2002, the leachate collection and removal system (LCRS) was connected on an interim basis to the header line that conveyed landfill gas to the onsite LFG-to-energy facility. Monitoring during the June 2002 scan indicated lower surface emissions than the previous scan, but still elevated compared to the northeast anaerobic cell most, likely because waste placement activities were still underway and a cover system had not been installed. In December 2002, the cover system was completed and the average emissions detected during the January scan declined. By March 2003, the gas collection system had been completed but the average emissions detected increased. In response to this increase, additional suction was applied to the landfill gas collection system to increase the flow rate from 16 standard cubic feet per minute (scfm) to 44 scfm. In April 2003, the average emissions detected decreased even though higher emissions were detected on the east face of the cell. The source of the high emissions was generally traced to unsealed areas on the cell (less than 1 inch) where piping penetrates the surface liner. In response to these emissions, three additional wells were opened and placed under suction in the area where the surface emissions were detected (increasing the LFG flow rate from 38 scfm to 99 scfm). Prior to the surface scan in September 2003, the pipe penetrations were sealed with expanding foam. While the average emissions detected in September 2003 were lower than previous surface scans, surface emissions were not completely eliminated because small leaks still existed at the junctions between the foam and the liner.

Similar conclusions (as presented for the northeast anaerobic cell) regarding the status of the surface cover in relation to the amount of surface emission can be drawn for the west-side anaerobic cell. Prior to September 2003, no significant “ballooning” was observed on the west-side anaerobic cell while the LFG collection system was shutdown. This is most likely because any excess gas buildup was escaping out the small gaps between the liner and piping (which would result in higher surface emission measurements). Subsequently, the pipe penetrations were sealed with the expansion foam. As a result, during a gas collection system shutdown in September 2003, positive pressure built-up under the surface cover, causing the liner to slightly “balloon.” These observations in combination with the September 2003 surface scan indicate that the foam was effective at reducing emissions, however was not completely effective at eliminating them.

Because small gaps existed between the surface liner and piping exiting the cell, the surface emissions detected from the west-side anaerobic cell were more dependant on the suction applied by the landfill gas extraction system. Figure 4-14 below compares the average surface emissions to the average suction applied to the landfill gas system. As presented in this graph, at higher suctions, average methane emissions dropped off significantly but because of the increased risk of oxygen intrusion in the cell. Yolo County plans to permanently seal these gaps rather than operate the gas extraction system at higher levels of suction.

Figure 4-14. Average Methane Emissions Detected from the West-Side Anaerobic Cell



The only current regulatory guideline for comparing the surface emissions from the bioreactor are found in 40 CFR 60, Subpart WWW, Standards of Performance for Municipal Solid Waste Landfills. Specifically, 40 CFR 60.755 requires landfills over a certain size to maintain surface methane emissions below 500 ppm. Comparing the readings obtained from the west-side anaerobic cell to the regulatory threshold of 500 ppm it is evident that the overall surface emissions from the cell are extremely low.

4.2.6 Waste Sampling

Yolo County conducted the second waste sampling event for the bioreactor project on July 15 and 16, 2003. In each of the bioreactor cells, two boreholes were drilled with a 24-inch diameter solid stem auger and samples were collected at approximately 5-foot intervals. These samples were then sent to North Carolina State University where they were analyzed to quantify the amount of decomposition that is possible under anaerobic conditions. Results will be available in the coming year. Refer to section 3.2.6 for images of the event.

Results from the first round of sampling in June 2002 indicate that the biochemical methane potential (BMP) of samples collected from the west-side anaerobic cell is approximately 31.82 ml/gram (0.51 cubic feet per pound). The results from this sampling event appear unusually low given the generally accepted methane potential of waste between 1.5 and 1.8 cubic feet per pound. It is possible that the low methane potential of the waste collected from this sampling event is not representative of the actual methane potential of the waste in the cell. As additional data is collected during subsequent sampling events, comparisons between theoretical methane potential and actual measured methane generation will allow further evaluation of the data.

5 AEROBIC CELL

The aerobic cell occupies approximately 2.5 acres in the southeast quadrant of Phase 1, Module 6D.

5.1 Experimental

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

5.1.1 Construction

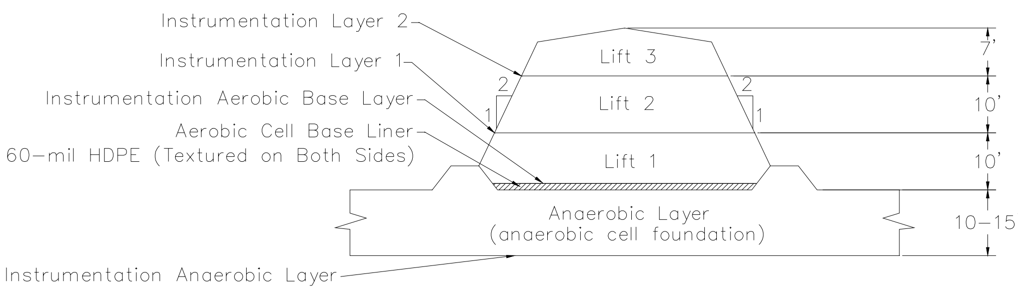
Construction of the aerobic cell can be generally broken down into five major tasks: waste placement, liquid addition, gas collection, air injection and surface liner installation. Each of the five tasks is discussed below. Refer to Appendix A, Table 5-1 for a summary of current monitoring data for the aerobic cell.

5.1.1.1 Waste Placement

Waste placement first began November 14, 2000 with an approximate 10-foot lift of waste placed on the Module 6D liner. This first lift of waste will act as a buffer between the Module 6D primary liner and the future aerobic cell. The waste was graded to promote drainage and a 60-mil HDPE geomembrane (Image 5-1) was installed to capture all leachate being generated by the aerobic cell. A sixteen-ounce geotextile was then placed on the membrane to act as a cushion for a shredded tire operations layer.

Image 5-1. Aerobic liner ready for shredded tire operations layer and waste placement

Waste placement in the aerobic cell occurred between August 8, 2001 and September 26, 2001. Waste was placed in three 10-foot lifts with 2:1 side slopes on the north, east and west (internal side slopes), and a 3:1 side slope on the south (external side slope) as presented in Detail 5-1. Because of the limited tipping area of the aerobic cell, self-haul waste was excluded. The use of daily cover soil during waste filling was also 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. To further aid permeability of the waste, compaction was restricted to only 1to 2 passes with a Caterpillar 826 compactor. Based on waste tonnage records and as-built topography, the in-place refuse density is approximately 800 pounds per cubic yard. Instrumentation Layers 1 and 2 were placed between lifts, and base layer instrumentation was installed on the aerobic cell base liner. A summary of sensors installed on each layer is provided in Appendix A, Table 5-2.



Detail 5-1. Aerobic Cell Cross Section Cell

5.1.1.2 Liquid Addition

Horizontal liquid injection lines were installed in each lift of waste. Injection lines within the waste (between lifts 1 and 2, 2 and 3) were placed horizontally (north to south) every 20 feet. Injection lines on top of lift 3 were placed east to west every 20 feet. Various combinations of 1¼-inch-diameter chlorinated polyvinyl chloride (CPVC) and 1¼-inch-diameter HDPE pipe were installed and perforated with $^{3}/_{32}$–inch-diameter holes spaced every 10 feet (Image 5-2). Because of the elevated temperatures expected in the aerobic cell, CPVC was installed a selected locations as a redundancy in the event the HDPE piping fails (CPVC is rated for service at temperatures up to 200^{o}F, however is approximately 4 times as expensive). A total of 4,780 feet of injection piping was installed with a total of 326 injection holes.

Image 5-2. Leachate injection laterals in trench

Each of the injection laterals is be connected to a 4-inch-diameter HDPE injection header. Individual solenoid valves were installed on each leachate injection lateral and connected to the Supervisory Control and Data Acquisition (SCADA) system used to monitor the various sensors and control the operation of the bioreactor. Liquid injection volumes will be monitored with manual flow meters installed on each injection lateral A digital flow meter will monitor the total volume and flow rate being injected in the aerobic cell. A manual meter has been installed to measure total volume in the event that the digital meter fails.

5.1.1.3 Air Collection

Horizontal air collection lines were installed between each lift of waste. Air collection lines consist of various combinations of alternating 4 and 6–inch-diameter CPVC pipe and 6 and 8–inch-diameter corrugated metal pipe. Each air collection line utilizes shredded tires as the permeable media. The air collection lines between layers are spaced approximately 40 feet apart. A total of 1660 feet of horizontal air collection lines were installed. A summary of the air collection lines for the aerobic cell is shown in Appendix A, Table 5-3.

Each air collection line is connected to a 12-inch-diameter air collection header that will convey the gas to and on-site blower and biofilter. Each air collection line incorporates a pre-manufactured wellhead capable of controlling flow and monitoring flow rate, temperature and pressure.

Construction of the blower station was completed in June 2003 (Image 5-3) and the biofilter was completed in September 2003. Two separate biofilters was constructed, each approximately 100 feet long and 20 feet wide. Piping to convey the aerobic cell gas was installed directly on the biofilter base, which was composed of approximately 1 foot of wood chips (Image 5-4). Two 1-foot lifts of biofilter media, composed of approximately six parts wood chips to one part compost, were placed above the base. Between each of these lifts, 10 temperature sensors and 10 moisture sensors were installed (Image 5-5). A final 2-foot lift of biofilter media was placed on top the biofilter. Limestone was sprinkled between each lift as a buffering agent to balance the pH of the biofilter media, which will tend to become more acidic during operation (Image 5-6).

Image 5-3: Aerobic Cell Blower Station

Image 5-4. Biofilter base with piping installed.

Image 5-5. Placement of biofilter media.

Image 5-6. Limestone sprinkled on the first lift of the biofilter.

5.1.1.4 Surface Liner

Vector was retained to provide design, plans and specifications for a surface lining system, including a biofilter for the treatment of the aerobic off-gas.

Since the operation of an aerobic bioreactor at the Yolo County Central Landfill was first considered, two methods of air management for oxygen delivery have been discussed. One method is to push air into the landfill and the other is to apply a vacuum and draw air through the landfill. Both methods have advantages and disadvantages. However, Yolo County has decided that the best alternative is to leave the aerobic cell covered with soil and greenwaste (shredded yard waste), but without an impermeable geomembrane, so that air could be drawn through the waste by applying a vacuum. In this way, air will enter through the cell surface and migrate to horizontal pipelines to which a vacuum is applied. Alternate operations plans could include using some of the installed pipelines as vents and others for vacuum.

Yolo County had intended to cover the aerobic cell with an exposed geomembrane with a biofilter at the top of the cell to provide some treatment of the off-gas. However, the weight of the geomembrane that would have been placed on the aerobic cell along with the weight of a sandbag surface ballast system would result in a pressure equivalent to only 0.17 inches of water. Calculations indicate that the required pressure present in the cell to force the air through the waste, to the top of the cell, and through the biofilter would result in a great deal of ballooning of the surface liner. Additionally, the expected high settlement rate would create a great deal of maintenance difficulties for the geomembrane surface liner.

Yolo County developed a design for a geomembrane surface liner for the aerobic cell and advertised for bids on the construction. The bids received were very expensive and not within the budget of the project. As a result of both the technical and economic difficulties encountered, it was decided that leaving the aerobic cell without a geomembrane liner is the preferred approach.

5.1.2 Monitoring

Temperature, moisture, leachate quantity and quality, and air pressure and composition are monitored through an array of sensors placed within the waste (Image 5-7) and in the leachate collection and recovery system (LCRS).

Image 5-7. Moisture, temperature, and tube installation

Each sensor location received a temperature sensor (thermistor), a moisture sensor (a PVC moisture sensor and in some cases a gypsum block) and a linear low-density polyethylene (LLDPE) tube. For protection, each wire and tube was encased in a 1.25-inch-diameter HDPE pipe. Temperature sensors, moisture sensors, and pressure transducers are each connected to the Supervisory Control and Data Acquisition (SCADA) system used for monitoring and controlling the operation of the bioreactor. Refer to Appendix B, Details 5-2 through 5-5 for sensor location diagrams.

Sensors on instrumentation Layers 0.5, 1, and 2 were placed on a bedding of greenwaste (shredded yard waste), or bin fines (fine pieces of greenwaste). Sensors installed on the primary liner (prior to any waste placement) were placed on the geotextile and covered with pea gravel prior to the placement of the shredded tire operations layer.

5.1.2.1 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.

5.1.2.2 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.

The gypsum blocks are manufactured by Electronics Unlimited and are typically used for soil moisture determinations in agricultural applications. Gypsum blocks establish equilibrium with the media in which they are placed and are, therefore, reliable at tracking increases in the soil's moisture content. However, the gypsum block can take considerable time to dry and therefore may not reflect the drying of the surrounding environment.

5.1.2.3 Leachate Quantity and Quality

Leachate that is generated from the aerobic cell will drain to a separate leachate sump installed on top of the eastside Module D leachate collection sump (Image 5-8). 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 will measure rate and total volume pumped from the sump.

Image 5-8. Aerobic sump installed and ready for backfill

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, 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 amended Waste Discharge Requirements in Order 5-00-134).

5.1.2.4 Pressure

Pressure within the aerobic 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.

5.1.2.5 Landfill Gas Composition and Flow

Landfill gas composition and flow are measured from the pre-manufactured well heads utilizing a GEM-500 combustible gas meter, manufactured by LANDTEC. 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.

5.1.2.6 Surface Emissions

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.

Methane concentrations are monitored with a model TVA-1000 Flame Ionization Detector (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.

5.1.3 Operation

Operation of the aerobic cell is anticipated to begin in late 2003.

5.1.3.1 Leachate Addition and Recirculation

Initially, large volumes of liquid will be added to bring the waste to field capacity (Image 5-9). Once field capacity has been reached, only enough liquid to maintain field capacity will be added. We anticipate that greater volumes of liquid (compared to the anaerobic cells) will be necessary to maintain field capacity due to the removal of liquid by the air collection system.

Image 5-9. Aerobic leachate injection header and lateral

5.1.3.2 Air Collection

From January 2003 through July 2003, landfill gas was collected to prevent surface emissions from the cell. On July 31, 2003, the gas collection header line was disconnected from the gas to energy facility and connected to the biofilter system in preparation of operation. Due to delays in construction, operation did not commence in the following months and the piping was reconnected to the gas to energy facility on September 30, 2003. Once operation of the aerobic cell commences, off-gas will be collected and sent to the biofilter for treatment.

5.2 Results And Discussion

Sensor names are represented numerically by the instrumentation layer in which the sensor is located and by the assigned sensor number. The base layer is represented by a 0, Layer 1 is represented by a 1, 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.

5.2.1 Temperature

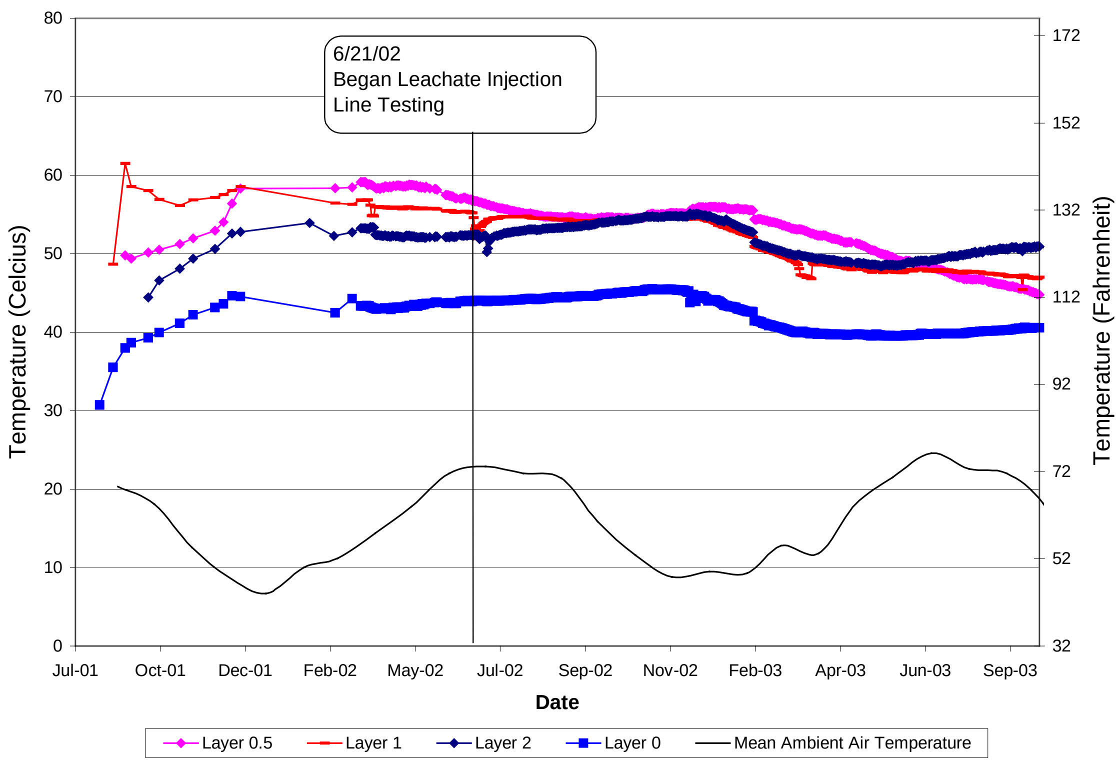
Temperature is monitored with thermistors manufactured by Quality Thermistor, Inc. Thermistors with a temperature range of 0°C to 100°C were chosen so they would be able to accommodate the temperature ranges expected in both the anaerobic and aerobic cells. Resistance was measured by the SCADA system located in the instrumentation shed starting in March 2002. Resistance was previously measured manually by connecting the sensor wires to a 26 III Multimeter manufactured by Fluke Corporation.

Temperature results are presented in Appendix C, Figures 5-1 to 5-4. A summary of the results is presented below in Table 5-5 and Figure 5-4.

Table 5-4. Temperature Summary for the Aerobic Cell

	Previous Reporting Period (04/01/03 to 06/30/03)			Current Reporting Period (07/01/03 to 09/30/03)		
Layer	Minimum Temp. (°C)	Maximum Temp. (°C)	Average Temp. (°C)	Minimum Temp. (°C)	Maximum Temp. (°C)	Average Temp. (°C)
0	25.6	56.3	39.7	30.7	54.5	40.1
0.5	40.7	57.7	50.4	34.6	56.2	46.4
1	5.9	63.5	48.0	6.0	59.1	47.4
2	48.4	65.7	48.7	49.0	69.1	50.2

Figure 5-5. Average Temperatures for the Aerobic Cell



5.2.2 Moisture

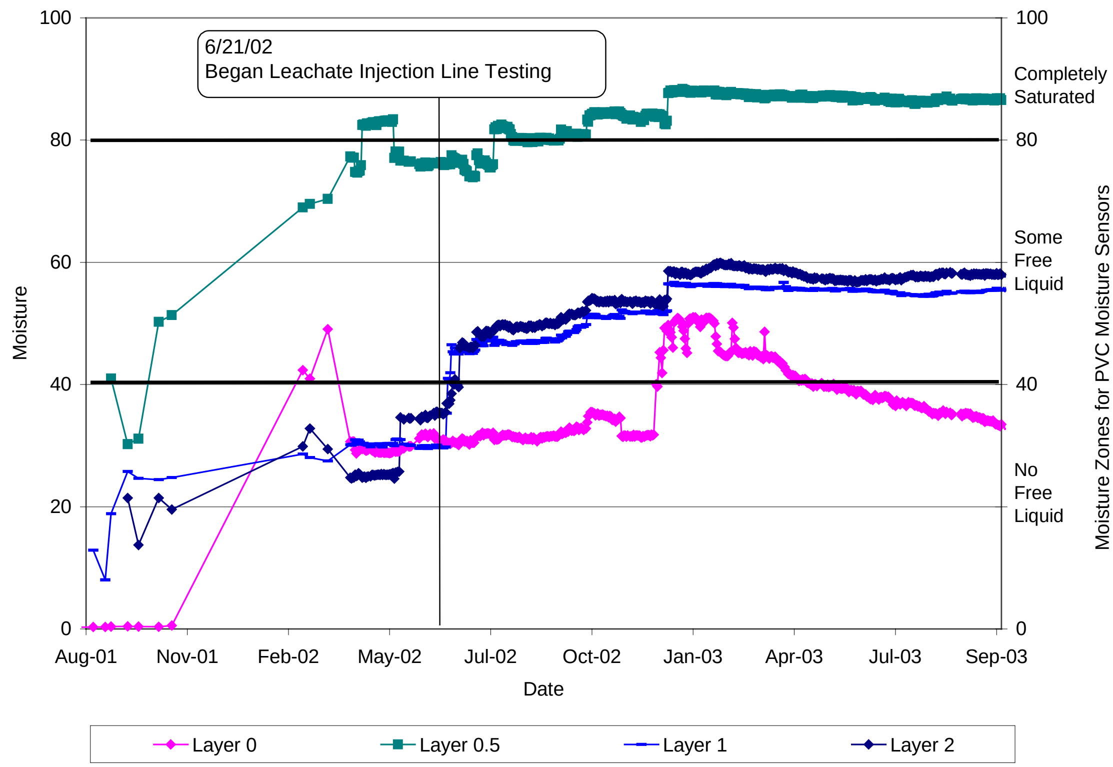
The SCADA system started electronically measuring moisture in March 2002. Moisture was previously measured manually with a Model MM 4 moisture meter manufactured by Electronics Unlimited. During the pilot scale project, Yolo County conducted laboratory tests with the PVC sensors to determine the relationship 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.

PVC moisture results are presented in Appendix C, Figures 5-6 to 5-9. A summary of the results is presented below in Table 5-5 and Figure 5-10.

Table 5-5. PVC Moisture Summary for the Aerobic Cell

	Previous Reporting Period (04/01/03 to 06/30/03)			Current Reporting Period (07/01/03 to 09/30/03)		
Layer	**Minimum Moisture**	**Maximum Moisture**	**Average Moisture**	**Minimum Moisture**	**Maximum Moisture**	**Average Moisture**
0	3.7	91.9	39.4	3.8	87.7	35.4
0.5	80.0	93.9	87.0	79.7	93.1	86.5
1	9.5	88.9	55.5	9.3	88.2	55.0
2	5.1	86.6	57.4	5.8	83.5	57.9

Figure 5-10. Average Moisture Levels for the Aerobic Cell



5.2.3 *Landfill Gas Collection*

Gas composition is measured from the wellheads located on top of the aerobic cell with the GEM-500. Gas flow is measured by differential pressure across an orifice plate utilizing a magnehelic pressure gauge by DWYER Instruments, Inc.

Landfill gas results are presented in Appendix C, Figures 5-11 through 5-13. Gas collection was stopped in July 31,2003 when piping that connected the aerobic cell header line to the LFG-to-energy facility was removed so that the aerobic header line could be connected to the blower station. On September 30, 2003 piping was reinstalled to connect the aerobic cell to the LFG-to-energy facility and gas collection resumed. A summary of the results is presented below in Table 5-6.

Table 5-6. Landfill Gas Summary for the Aerobic Cell.

Parameter	Results		
Cumulative Methane from January 13, 2003 to September 30, 2003	528,716 standard cubic feet (scf) (which is equivalent to approximately 84 barrels of oil)		
LFG Flow Rate for the period of July 1, 2003 to September 30, 2003	Minimum	Maximum	Average
	0 scf	9.1scf	12.8 scf
Methane Concentration for the period of July 1, 2003 to September 30, 2003	Minimum	Maximum	Average
	2.7 %	18.1 %	13.1 %

Landfill gas was sampled from the aerobic cell in August 2003 and sent to an independent laboratory for analytical testing. Analytical results are presented in Appendix D. No definitive trends can be concluded from the laboratory analysis of landfill gas samples collected from the aerobic cell because only 3 samples have been analyzed to date. Results indicate that some constituents have increased while others have decreased. Once additional sampling has been completed we expect a trend in decreasing VOC constituents over time.

1

5.2.4 Leachate Quantity And Quality

Leachate was last sampled in May 2002 for analytical testing. Analytical results are presented in Appendix E, Table 5-7. Field chemistry and selected analytical results are presented below in Table 5-8. Leachate will be sampled on a monthly basis once liquid addition commences and leachate has been generated.

Table 5-8. Field Chemistry and Selected Analytical Results for Leachate Sampled from the Aerobic Cell

PARAMETER	**DATE:**	**2/26/2002**	**3/27/2002**	**5/14/2002**	**5/29/2003**
Field Parameters:	**Units**				
PH		7.75	8.17	8.48	8.48
Electrical Conductivity	μS	7026	7705	9048	9426
Oxidation Reduction Potential	mV	195	195	127	201
Temperature	C	15.1	15.2	21.1	27.9
Dissolved Oxygen	mg/L	5.45	5.73	6.8	1.67
Total Dissolved Solids	ppm	5673	NA	7448	7686
General Chemistry:					
Bicarbonate Alkalinity	mg/L	1120	935	1020	1480
Total Alkalinity as CO_3	mg/L	1120	935	1050	1510
BOD	mg O/L	3.3	5	89	35
Chemical Oxygen Demand	mg O/L	595	563	602	818
Chloride	mg/L	1610	1800	2290	1740
Ammonia as N	mg/L	2.8	1.1	0.60(tr)	36
Nitrate-Nitrite as N	mg/L	0.16	0.22	4.8(tr)	4.8
Total Kjeldahl Nitrogen	mg/L	19.9	19.2	11.1	69.1
Total Dissolved Solids @ 180 C	mg/L	4810	5200	5640	6330
Total (Non-Volatile) Organic Carbon	mg/L	766	149	168	215
Total Sulfide	mg/L	<0.014	0.015(tr)	<0.014	<0.0093
Dissolved Iron	mg/L	0.32	0.084(tr)	0.34	0.81
Dissolved Magnesium	mg/L	273	260	220	401
Dissolved Potassium	mg/L	NA	66.1	47.8	165

5.2.5 Surface Emissions

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. The March 2003 aerobic cell surface scan was postponed until April 2003 due to technical difficulties with the instrument. A summary of the surface scans performed on the aerobic cell is presented below in Table 5-9.

Table 5-9. Summary of Surface Scans Performed on the Aerobic Cell

Date	Average Emissions Detected*	Max. Emissions Detected	Location of Maximum Emissions	Average Vacuum Applied by LFG Extraction System
04/03/02	0 ppm	0 ppm	Not applicable	0.0 Inches H_2O
06/06/02	2.17 ppm	8 ppm	Along the western perimeter of the cell	0.0 Inches H_2O
09/20/02	0.13 ppm	3 ppm	South face of the cell near the leachate collection sump	0.0 Inches H_2O
01/07/03	0.002 ppm	0.9 ppm	South face of the cell along a gas collection lateral.	0.0 Inches H_2O
04/30/03	0.64 ppm	3.6 ppm	Along the west perimeter, approximately 80 meters from the south toe of the cell.	-0.1 Inches H_2O
09/29/03	0.43 ppm	48.9 ppm	In the northwest region of the sump area located on the south side of the cell.	0.0 Inches H_2O

*Based on the weighted average of emissions detected along the entire traverse. Note that the gas system was only on during the 4/30/03 surface scan.

The extremely low surface emissions detected from the aerobic cell are not surprising given the low moisture content of the waste (very little water has been added) and full scale operation of the cell has not commenced. Once operation begins, future surface scans should be able to demonstrate the surface emission potential of an aerobic bioreactor landfill.

The detection of surface emissions may also be due to landfill operations in nearby areas. While background concentrations were monitored prior to conducting the surface scan, changes in wind currents could have transported methane from adjacent areas. During June 2002 and September 2002, grading and waste filling activities in the adjacent west-side anaerobic cell could have promoted the detection of gas emissions in the aerobic cell. Additionally, activities from Module D Phase II construction (which involved exposing waste from an adjacent unit to facilitate base liner installation) could have promoted the detection of gas emissions during the September 2002 surface scan. Surface emissions detected in April 2003 may be due to emissions from the west-side anaerobic cell. Higher surface emissions have been detected from the west-side anaerobic cell due to leakage from small gaps in the surface liner where piping exits the cell.

The gas to energy facility was only partially operational for several days prior to the September 2003 surface scan. As a result, landfill gas (from the northeast anaerobic cell) may have built up in the Module D base layer, which is directly below the sump area on the south side of the aerobic cell. Consequently, the detection of surface emissions in the sump area may be due to LFG emitted through cracks in the cover soil around the sump. This area will be closely monitored during the next surface scan scheduled in December 2003.

The only current regulatory guideline for comparing the surface emissions from the bioreactor are found in 40 CFR 60, Subpart WWW, Standards of Performance for Municipal Solid Waste Landfills. Specifically, 40 CFR 60.755 requires landfills over a certain size to maintain surface methane emissions below 500 ppm. Comparing the readings obtained from the aerobic cell to the regulatory threshold of 500 ppm it is evident that the overall surface emissions from the cell are extremely low.

5.2.6 Waste Sampling

Yolo County conducted the second waste sampling event for the bioreactor project on July 15 and 16, 2003. In each of the bioreactor cells, two boreholes were drilled with a 24-inch diameter solid stem auger and samples were collected at approximately 5-foot intervals. These samples were then sent to North Carolina State University where they were analyzed to quantify the amount of decomposition that is possible under anaerobic conditions. Results will be available in the coming year. Refer to section 3.2.6 for images of the event.

Results from the first round of sampling in June 2002 indicate that the biochemical methane potential (BMP) of samples collected from the aerobic cell is approximately 36.51 ml/gram (0.59 cubic feet per pound). The results from this sampling event appear unusually low given the generally accepted methane potential of waste between 1.5 and 1.8 cubic feet per pound. It is possible that the low methane potential of the waste collected from this sampling event is not representative of the actual methane potential of the waste in the cell. As additional data is collected during subsequent sampling events, comparisons between theoretical methane potential and actual measured methane generation will allow further evaluation of the data.

6 MODULE 6D BASE LINER

The three bioreactor cells share a common composite liner system, designated the Module 6D primary liner. This composite liner system was constructed in 1999 and was designed to exceed the requirements of Title 27 of CCR and Subtitle D of the Federal guidelines.

6.1 Experimental

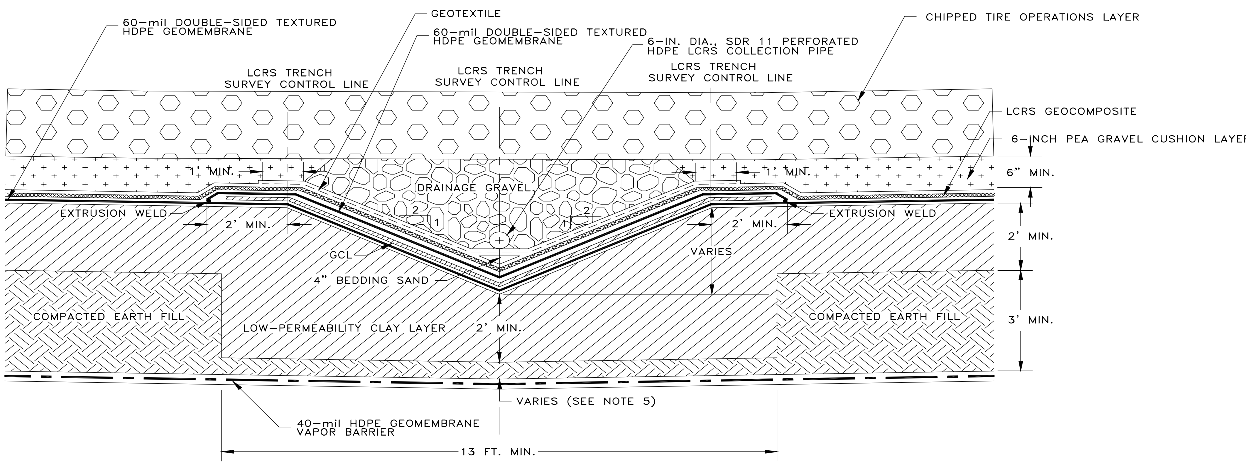
The experimental methods utilized are grouped into two categories: construction and monitoring. Each of these categories is discussed below.

6.1.1 Construction

Construction of the Module 6D primary liner system can generally be separated into two tasks: grading and base liner assembly.

6.1.1.1 Grading

The base layer of Module D was constructed in a ridge and swale configuration, enabling the west-side 6-acre anaerobic cell to be hydraulically separated from the northeast anaerobic cell and the aerobic cell in the southeast quadrant. The base layer slopes 2 percent inward to two central collection v-notch trenches located on the southeast and southwest side of Module D (Detail 6-1). Each of the trenches drain at 1 percent to their respective leachate collection sumps located at the south side of the module.



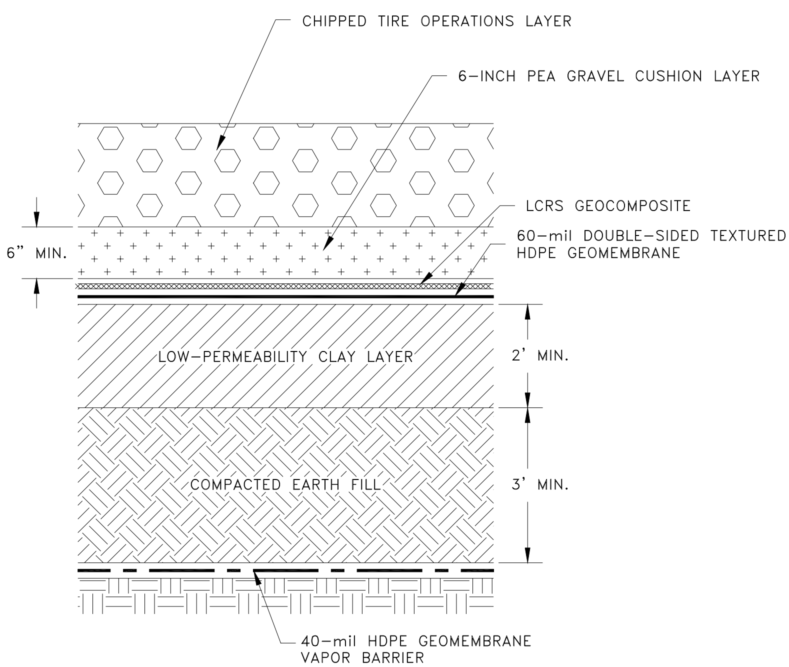
Detail 6-1. Module D Bottom Liner and Leachate Collection Trench Cross-Section

6.1.1.2 Base Liner Assembly

The liner is composed, from top to bottom, of the following materials: an operations/drainage layer consisting of 2 feet of chipped tires (permeability [k] > 1 centimeter per second [cm/s]) (Image 6-1), 6-inches of pea gravel, geocomposite drain net, a 60-mil high density polyethylene (HDPE) geomembrane, a 2–foot-thick compacted clay liner ($k < 6 \times 10^{-9}$ cm/s), 3 feet of compacted earth fill ($k < 1 \times 10^{-8}$ cm/s), a 40-mil HDPE vapor barrier layer, and a clay subgrade with 90-percent (ASTM D1557) relative compaction[4] (Detail 6-2).

[4] Golder Associates, "Final Report, Construction Quality Assurance, Yolo County Central Landfill, WMU 6, Module D, Phase 1 Expansion", December 1999.

Image 6-1. Shredded tire operations layer



Detail 6-2. Module D Bottom Liner Cross-Section

6.1.2 Monitoring

Temperature, moisture, and pressure are monitored through an array of sensors placed within the waste and in the leachate collection and recovery system (LCRS). Each sensor location on the base layer received a temperature sensor (thermistor), a linear low-density polyethylene (LLDPE) tube, and selected locations received a PVC moisture sensor. 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, Detail 6-3 for sensor location diagram.

Sensors installed on the primary liner (prior to any waste placement) were placed on geocomposite and covered with pea gravel prior to the placement of the chipped tire operations layer. A summary of sensors installed on the base liner is provided in Appendix A, Table 6-1.

As part of the requirements specified under Waste Discharge Requirements in Order 5-00-134, Yolo County is required to monitor liquid buildup on the liner. Under typical landfilling, liquid buildup on a Class III composite liner system must be maintained to less than 1 foot. In order to gain approval from the California Regional Water Quality Control Board to operate Module 6D as a bioreactor, Yolo County must maintain less than 4-inches of liquid buildup on the Module 6D primary liner[5]. Head over the liner is monitored through a series of pressure transducers and sampling tubes either in or next to the leachate collection trenches (Appendix C, Figure 6-10). In addition, sampling tubes located on the Module 6D liner (designations 0-1 through 0-66) are utilized to monitor head over the liner.

6.1.2.1 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.

6.1.2.2 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.

6.1.2.3 Leachate Collection Trenches

Three LLDPE sampling tubes were installed in each of the leachate collection trenches (Image 6-2). The tubes were installed inside a 2-inch-diameter PVC pipe for protection, and terminate at different points along the trenches. The sampling tubes can be hooked up to the same "Magnahelic" pressure gage, which reads directly in inches-of-water.

Pressure transducers were installed at three locations adjacent to each leachate collection trench. Additionally, tubes were installed that terminate adjacent to each of the pressure transducer locations (Appendix B. Detail 6-2). The pressure transducers provide an output current between 4 and 20 milliamps, which is directly proportional to pressure. The pressure transducers installed on the

[5] California Regional Water Quality Control Board, Central Valley Region, "Waste Discharge Requirements for the Yolo County Central Landfill, No. 5-00-134", June 16, 2000.

Module 6D liner are Model PTX 1830 manufactured by Druck, Inc. Their pressure range is 0 to 1 pounds per square inch (psi) and has+0 an accuracy of ±1 percent of full scale.

Image 6-2. Pressure tubes installed in LCRS trench

6.2 Results And Discussion

Tubes located in the leachate collection trenches are referred to as trench liquid level (TLL) tubes. Pressure transducers and their accompanying tubes that are located adjacent to the leachate collection trenches are denoted as PT or PT-TUBE respectively.

6.2.1 Temperature

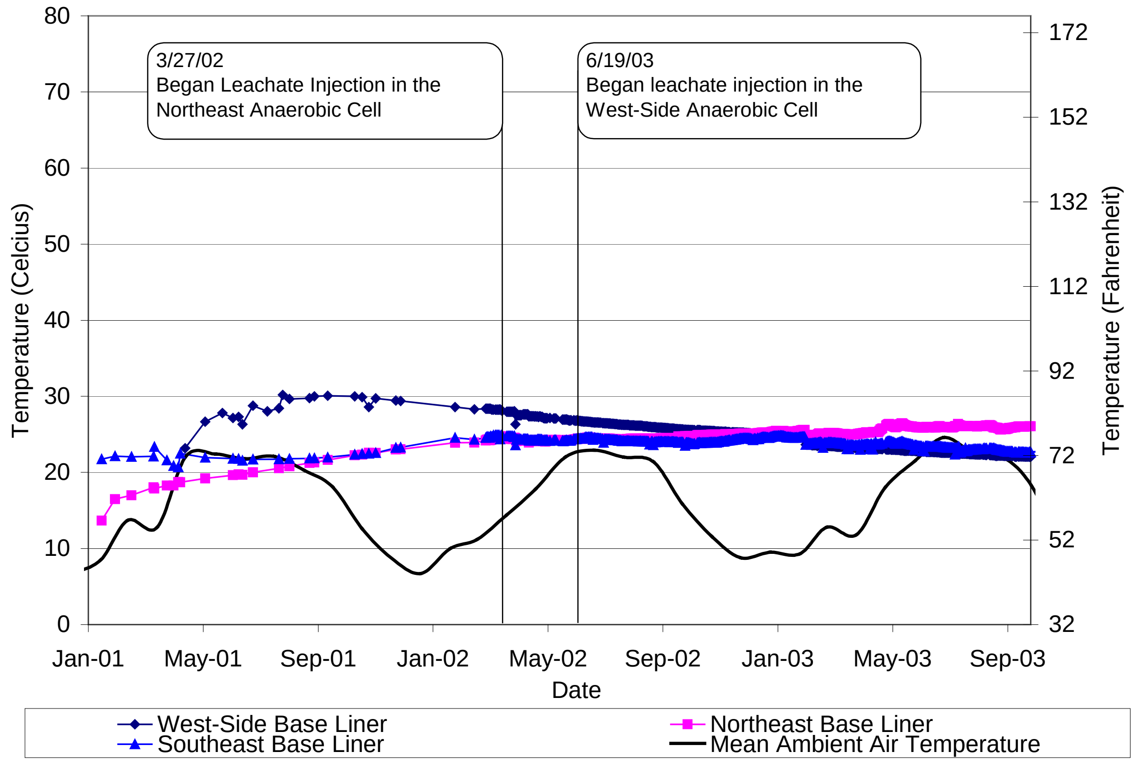
Temperature is monitored with thermistors manufactured by Quality Thermistor, Inc. Thermistors with a temperature range of 0°C to 100°C were chosen so they would be able to accommodate the temperature ranges expected in both the anaerobic and aerobic cells. Resistance was measured by the SCADA system located in the instrumentation shed starting in March 2002. Resistance was previously measured manually by connecting the sensor wires to a 26 III Multimeter manufactured by Fluke Corporation.

Temperature results are presented in Appendix C, Figures 6-1 to 6-4. A summary of the results is presented below in Table 6-2 and Figure 6-5.

Table 6-2. Temperature Summary for the Base Liner

	Previous Reporting Period (04/01/03 to 06/30/03)			Current Reporting Period (07/01/03 to 09/30/03)		
Location	**Minimum Temp. (°C)**	**Maximum Temp. (°C)**	**Average Temp. (°C)**	**Minimum Temp. (°C)**	**Maximum Temp. (°C)**	**Average Temp. (°C)**
Northwest	6.5	28.5	24.4	6.4	28.5	23.8
Southwest	14.3	27.2	22.9	13.3	26.7	22.3
Northeast	12.3	31.2	25.8	12.1	32.5	26.0
Southeast	8.3	33.8	23.6	7.2	35.5	22.9

Figure 6-5. Average Temperatures on the Base Liner



6.2.2 Moisture

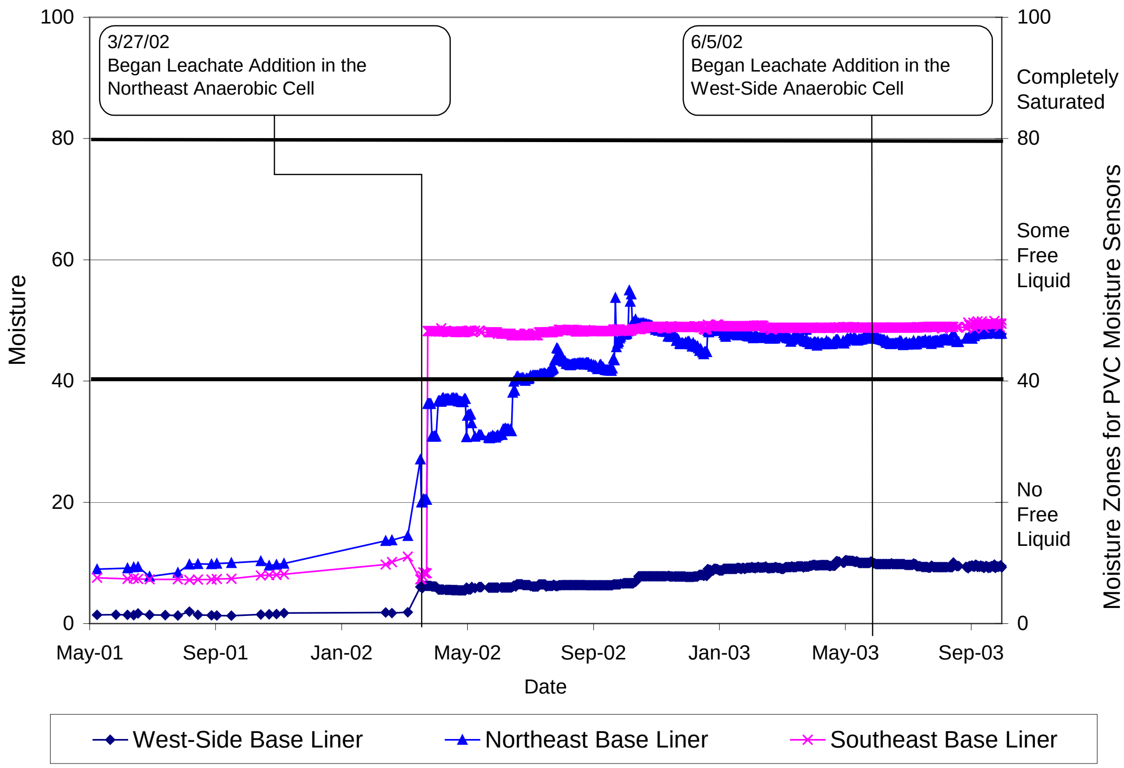
The SCADA system started electronically measuring moisture in March 2002. Due to a slight variation between how the SCADA system measures moisture compared to the manual meter, moisture readings generally increased a small fraction relative to their previous manually recorded readings. Because moisture data are unitless numbers that give a qualitative assessment rather than a quantitative measure, we feel that this slight change is not significant. Moisture was previously measured manually with a Model MM 4 moisture meter manufactured by Electronics Unlimited. 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 6-6 to 6-8. Results indicate that the average moisture levels on the east side of the base liner have increased to the some free liquid zone since the start of liquid injection in the northeast anaerobic cell in March 2002. The average moisture levels on the west side of the base liner have not shown a significant change since the start of liquid injection in the west-side anaerobic cell in June 2003. A summary of the results is presented below in Table 6-3 and in Figure 6-9.

Table 6-3. PVC Moisture Summary for the Base Liner

	Previous Reporting Period (04/01/03 to 06/30/03)			Current Reporting Period (07/01/03 to 09/30/03)		
Location	**Minimum Moisture**	**Maximum Moisture**	**Average Moisture**	**Minimum Moisture**	**Maximum Moisture**	**Average Moisture**
West-Side	6.8	20.2	9.9	5.2	20.1	9.4
Northeast	27.8	88.2	46.6	28.2	88.2	47.1
Southeast	9.3	88.2	48.8	9.1	88.2	49.1

Figure 6-9. Average Moisture Levels on the Base Liner



6.2.3 Leachate Collection Trenches

Liquid level data adjacent to the leachate collection trenches is presented in Appendix C, Figure 6-10. Pressure transducer three shows increasing liquid levels that are not supported by data from other sensors. In April 2003, pressure transducers were pulled from the base liner, tested for accuracy, and then pulled back to their original locations. To test the pressure transducers they were immersed in a barrel filled with water of varying depths and the actual depth of water was compared to the output signal of the transducer (Image 6-3). Several of the pressure transducers exhibited fluctuating readings although the depth of water was constant. Typically this fluctuation was plus or minus one-inch of the actual depth (e.g. if the actual depth of water was 12 inches the output signal of the transducer would drift between 11 and 13 inches.) In an effort to determine the cause of this problem, the manufacturer was contacted and it was determined that the most likely cause of the error was the presence of water in the pressure transducers vent line. Yolo County plans to remove the water by applying a gentile vacuum (approximately 8 psi, anything greater would adversely affect the transducer) to the vent line. The transducers will then be retested by immersing them in a barrel of water.

Image 6-3. Pressure transducers were tested for accuracy by submerging the sensors in water at various depths.

On May 22, 2003, pressure transducer six (Appendix B, Detail 6-3) located on the bottom liner detected a maximum 9.21 inches of liquid. This elevated liquid level was due to the temporary shut-down of the lechate collection and removal system (LCRS) pumps for maintenance. Once the pumps were restarted, liquid levels dropped and within 10 hours the depth of liquid at pressure transducer 6 was less than 4–inches. Since this occurrence, head on the liner has not surpassed 4 inches. Results generally indicate that liquid levels on the base liner have not significantly increased since the start of liquid injection in the northeast anaerobic cell in March 2002 and the start of liquid injection in the west-side anaerobic cell in June 2003. A summary of the results is presented below in Table 6-4.

Table 6-4. Leachate Level Summary for the Base Liner

	Previous Reporting Period (04/01/03 to 06/30/03)			Current Reporting Period (07/01/03 to 09/30/03)		
Pressure Transducer	Min. Level (In. of Water)	Max. Level (In. of Water)	Avg. Level (In. of Water)	Min. Level (In. of Water)	Max. Level (In. of Water)	Avg. Level (In. of Water)
1	0.26	0.42	0.36	0.37	0.47	0.41
2	0.54	0.70	0.62	0.47	0.65	0.57
3	1.40	2.01	1.69	1.39	1.95	1.60
4	0.01	0.22	0.09	0.21	0.40	0.29
5	0.01	0.58	0.30	0.03	0.49	0.30
6	0.01	9.21	0.24	0.01	0.27	0.15

7 CONCLUSION

Full-scale operation is underway in the northeast anaerobic cell and the west-side anaerobic cell and results are generally as expected. In the northeast anaerobic cell and west-side anaerobic cell, moisture sensors have generally increased since the start of liquid addition and temperatures within the cells are normal and within the range necessary for anaerobic decomposition.

After 18 months of liquid injection into the northeast anaerobic cell, results demonstrate that supplemental liquid can successfully be added to a bioreactor landfill while preventing an increase in hydraulic head over the primary liner. While liquid addition to the west-side anaerobic cell has only recently begun, large volumes of supplemental liquid have already been added and the hydraulic head over the primary liner has not been significantly affected. As liquid addition continues in the bioreactor cells, the moisture content of the waste, the ability of the waste to retain liquid, and the leachate recirculation rates will be closely monitored to prevent a build-up of head over the liner.

The rate of liquid addition can affect bioreactor operation. In the northeast anaerobic cell, leachate addition averaged 1,050 gallons per day per acre. In the west-side anaerobic cell, leachate addition averaged 2,500 gallons per day per acre. This 2.4 times increase in the leachate addition rate caused some leachate seeps to develop along the west face of the module coming from the horizontal trenches where piping was installed. This was easily repaired by installing a toe drain

The drop in BOD_5 levels in the northeast anaerobic cell was unexpected and further data will need to be collected to determine the cause. The County has traced the probable source of air intrusion into the permeable LCRS layer to desiccation cracks in the soil cover overlying the leachate sump. This winter additional soil will be placed to seal the cracks and a plastic sheeting material such as geomembrane will be installed over the area to help prevent air intrusion. Once this is complete, if BOD_5 levels increase then it was most likely the oxygen in the LCRS layer that caused the low BOD_5 levels.

The total landfill gas production from the northeast anaerobic cell continues to lag behind that observed in the pilot scale project. During the first 473 days of leachate injection in the pilot scale cell, approximately 0.70cubic feet of landfill gas per dry pound of waste was collected. In contrast, through the same 473 days of injection, approximately 0.32 cubic feet of landfill gas per dry pound of waste has been collected from the northeast anaerobic cell. There are two possible explanations for the lower production from the northeast anaerobic cell. The first possible explanation is that the waste that comprises the pilot scale enhanced cell was entirely composed of waste delivered in compactor trucks, which has a relatively high biodegradable fraction do to the high percentage of residential waste. In contrast, the northeast anaerobic cell received all waste that was accepted at the landfill, which would include among other things, construction and demolition debris and other non-readily degradable material, neither of which would be expected to produce any significant methane. The second possible explanation is that liquid was added to the pilot scale enhanced cell from the top with a denser injection point spacing in comparison to the northeast anaerobic cell where liquid was initially added to the first lift and then gradually to each subsequent lift. As a result, the pilot scale enhanced cell may have obtained better moisture distribution earlier on in the project due to a different injection strategy which also may have impacted the initial gas production from the northeast anaerobic cell. As liquid continues to be added to the upper lifts of the cell, we expect the rate of gas production to increase to levels obtained in the pilot scale enhanced cell.

Because gas production from the west-side anaerobic cell is still in its initial stages, few conclusions can be drawn as to the performance of this cell. Initial data indicate an increase in landfill gas generation following the start of liquid addition in June 2003. As additional data is collected, we expect gas production to resemble the northeast anaerobic cell.

Recent analytical results for most VOC constituents show a continued decreasing trend in the northeast anaerobic cell. As decomposition continues, we expect the landfill gas trace constituents to continue to decline in a similar fashion as the original pilot project. With only a few samples collected from the west-side anaerobic cell and aerobic cell, insufficient data exists to establish trends. As further data is collected, we expect results from the west-side cell and aerobic cell to be similar to those obtained from the northeast cell.

The average methane emissions from the bioreactor cells have generally been low and continue to remain below federal regulations (40 CFR 60.755) that cap the maximum allowable surface emissions at 500 ppm. While higher emissions have been detected on the west-side anaerobic cell than on the northeast anaerobic cell or aerobic cell, the results have been useful in demonstrating the need for a non-permeable cover system and an active gas extraction system to minimize surface emissions. As a permanent solution to eliminate surface emissions on the west-side anaerobic cell, Yolo County is currently planning to seal the pipe penetrations in December 2003 with permanent boots made of high-density polyethylene (HDPE) liner that will be extrusion welded to the surface liner.

8 REFERENCES

1. Vector Engineering, “Design Report for the Surface Liners of the Module D Phase 1 Bioreactors at the Yolo County Central Landfill”, October 2001.

2. Yazdani, R., Moore, R. Dahl. K. and D. Augenstein 1998 Yolo County Controlled Landfill Bioreactor Project. Yolo County Public Works and I E M, Inc. Yolo County Public Works and I E M, Inc. report to the Urban Consortium Energy Foundation (UCETF) and the Western Regional Biomass Energy Program, USDOE.

3. Tchobanoglous et al, “Integrated Solid Waste Management, Engineering Principles and management Issues”, McGraw-Hill, 1993.

4. Golder Associates, “Final Report, Construction Quality Assurance, Yolo County Central Landfill, WMU 6, Module D, Phase 1 Expansion”, December 1999

5. California Regional Water Quality Control Board, Central Valley Region, “Waste Discharge Requirements for the Yolo County Central Landfill, No. 5-00-134”, June 16, 2000.

APPENDIX A – EPA XL SCHEDULE AND SUMMARY OF MATERIALS INSTALLED

Table 1-1. Revised Project XL Delivery Schedule

Project Task	Delivery Date
• RWQCB approved the revised Waste Discharge Requirement Permit	June 22, 2000
• Final draft FPA circulated to stakeholders for comments	June 22, 2000
• Comments received for Final Project Agreement (FPA) • Instrumentation installation began	July 3, 2000
• Finalize FPA and distribute for signature	July 21, 2000
• All parties sign FPA document	September, 2000
• Final Rule for Yolo County XL Project published in Federal Register	August 30, 2001
• First lift of waste completed in the southeast corner of Module 6D. This lift of waste is to be used as the foundation layer for the aerobic cell liner.	January 2001
• Waste placement begins in the northeast 3.5 acre anaerobic bioreactor	January 2001
• Begin monitoring temperature and moisture of waste	January 2001
• Begin waste placement in west 6-acre anaerobic cell (waste placement alternates between the west and northeast anaerobic bioreactors and the aerobic bioreactor to facilitate placement of instrumentation, piping, etc.)	March 2001
• Completed construction of aerobic cell liner and begin waste placement in aerobic cell	July 2001
• Complete the following for the northeast anaerobic 3.5-acre cell: waste placement, instrumentation, leachate injection system, air injection system, and gas and leachate monitoring	September 2001
• Complete the following for the aerobic bioreactor: waste placement, instrumentation, data acquisition and control system, leachate injection system, air management system, gas and leachate monitoring	June 2003
• Begin liquid addition to the northeast 3.5-acre anaerobic cell	November 2001
• Begin liquid addition and air injection in aerobic bioreactor	August 2003
• Complete the following for the west anaerobic 6-acre cell: waste placement, instrumentation, data acquisition and control system, leachate injection system, gas collection system, gas and leachate monitoring, and cover system	October 2002
• Begin liquid injection in the west side 6-acre anaerobic bioreactor	August 2003
• Data collection and reporting will continue	On-going until waste stabilization is complete, but dependent on sustained funding levels

Table 3-1. Summary of Data for the Northeast Anaerobic Cell

Description	Data
Footprint	3.4 acres
Average Waste Depth	35 feet
Construction of the Base Liner	1999
Waste Filling of Cells	1/13/2001 – 8/3/2001
Total # of Waste Lifts	4
Total Amount of Waste	65,104 tons
Total Amount of Greenwaste ADC[1]	11,060 tons
Volume of Soil Within the Waste Mass[2]	5,970 cubic yards
Ratio of Waste to Greenwaste ADC	5.9 to 1
Ratio of Waste to Greenwaste ADC and Soil	3.4 to 1
Average Density of Waste	1,162 pounds per cubic yard, lbs/cy (does not include soil or ADC)
Total # of Horizontal Gas Collection Lines[4]	17 Spacing of approximately 40 feet on center
Layer 1	6
Layer 2	5
Layer 3	3
Layer 4	3
Total # of Liquid Addition Lines (HDPE Pipe) [5]	25 Spacing of approximately 40 feet on center
Layer 1	8
Layer 2	7
Layer 3	5
Layer 4	5
Total Amount of Liquid Addition Piping	7,990 feet
Layer 1	3,080 feet
Layer 2	2,450 feet
Layer 3	1,500 feet
Layer 4	960 feet
Total # of 3/32 inch Diameter Holes in Injection Line	337
Layer 1	145
Layer 2	93
Layer 3	55
Layer 4	44
Surface Liner	36-mil[6] Reinforced Polypropylene

[1]ADC-Alternative Daily Cover
[2]This is an estimate
[4]Refer to Table 3 for a complete description of gas collection lines
[5]High Density Polyethylene, HDPE
[6]1-mil is equivalent to 0.001 inches and refers to the thickness of the liner

Table 3-2. Summary of Sensors for the Anaerobic Cells

Type of Instrumentation	FPA Proposed Location/Quantity/Spacing	Northeast Anaerobic Cell Actual Location/Quantity/Spacing	West-Side Anaerobic Cell Actual Location/Quantity/Spacing
Bubbler Gage for Liquid/Gas Pressure Measurement and Liquid/Gas Sampling	1. Top of the first lift of waste- 55 gages 2. Top of the second lift of waste-40 gages 3. Top of the third lift of waste-30 gages 4. Top of the final lift of waste-20 gages TOTAL= 145 gages	1. Top of the first lift of waste- 15 gages at 75 feet spacing 2. Top of the second lift of waste-13 gages at 75 feet spacing 3. Top of the third lift of waste- 13 gages at 75 feet spacing 4. Top of the final lift of waste- no gages TOTAL= 41 gages	1. Top of the first lift of waste- 6 gages at various spacing 2. Top of the second lift of waste-7 gages at various spacings 3. Top of the third lift of waste- no gages 4. Top of the final lift of waste- no gages TOTAL= 13
Moisture and Temperature Sensors	1. Top of the first lift of waste-55 temperature and moisture sensors 2. Top of the second lift of waste-40 temperature and moisture sensors 3. Top of the third lift of waste-30 temperature and moisture sensors 4. Top of the final lift of waste-20 temperature sensors TOTAL= 145 temperature sensors and 125 moisture sensors	1. Top of the first lift of waste-18 temperature and 18 moisture sensors at 75 feet spacing 2. Top of the second lift of waste-16 temperature and 39 moisture sensors at 75 feet spacing 3. Top of the third lift of waste-13 temperature and 13 moisture sensors at 75 feet spacing 4. Top of the final lift of waste- no sensors TOTAL= 47 temperature sensors and 70 moisture sensors	1. Top of the first lift of waste-6 temperature and 6 moisture sensors at various spacings 2. Top of the second lift of waste-43 temperature and 43 moisture sensors at various spacings 3. Top of the third lift of waste-14 temperature and 14 moisture sensors at various spacings 4. Top of the final lift of waste- no sensors TOTAL= 63 temperature sensors and 63 moisture sensors

Because the original project was altered from constructing one 9.5-acre anaerobic cell to constructing two anaerobic cells, one occupying 6-acres and one occupying 3.5-acres, waste placement area was lost in the valley separating the two anaerobic cells. This resulted in the installation of fewer sensors over the 9.5-acre area than initially proposed.

Table 3-3. Summary of Gas Collection Lines for the Northeast Anaerobic Cell

Gas Collection Line[1]	Description	Spacing
1-G1	Alternating 4 and 6 inch schedule 80 PVC[2].	50' from west toe
1-G2	Shredded tires with pipe at ends. The north end is 40 feet of schedule 40 PVC with a 10 foot section of 3 inch perforated schedule 80 PVC. The south end is 40 feet of 4 inch schedule 80 PVC, 5 feet of 3 inch schedule 80 PVC, and 10 feet of perforated HDPE.	40' from 1-G1-NE
1-G3	Alternating 4 and 6 inch schedule 80 PVC.	40' from 1-G2-NE
1-G4	Shredded tires with PVC pipe at ends. The south end is 40 feet of 4 inch schedule 80 PVC and 10 feet of 6 inch schedule 80 PVC. The north end is 40 feet of 4 inch schedule 40 PVC.	40' from 1-G3-NE
1-G5	Shredded tires with PVC pipes at ends. The south end is 40 feet of 4 inch schedule 80 PVC, 10 feet of 6 inch schedule 80 PVC, 20 feet of 4 inch schedule 80 PVC, and 5 feet of 24 inch corrugated HDPE. The north end is 40 feet of 4 inch schedule 40 PVC.	40' from 1-G4-NE
1-G6	Shredded tires with PVC pipes at ends. The south end is 40 feet of 4 inch schedule 80 PVC, 20 feet of 3 inch perforated schedule 80 PVC, 10 feet of 6 inch schedule 80, and 20 feet of 3 inch perforated schedule 80 PVC. The north end is 40 feet of 4 inch schedule 40 PVC.	40' from 1-G5-NE
2-G1	Shredded tires with PVC pipes at ends. The south end is 40 feet of 4 inch schedule 80, 10 feet of 6 inch schedule 80, and 10 feet of 4 inch schedule 80 PVC. The north end is 40 feet of 4 inch schedule 40 PVC.	30' from West toe
2-G2	Alternating 4 and 6 inch schedule 80 PVC pipe for the entire length with 40 feet of 4 inch at the north and south end.	40' from 2-G1-NE
2-G3	Shredded tires with PVC pipe at the ends. The north end is 40 feet of 4 inch schedule 40 PVC. The south end 40 feet of 4 inch schedule 80 PVC, 20 feet of 3 inch schedule 80 PVC, 10 feet of 6 inch schedule 80 PVC, and 20 feet 3 inch perforated schedule 80 PVC.	40' from 2-G2-NE
2-G4	Alternating 6 and 3 inch schedule 80 PVC pipe. The south end is 4 inch schedule 80 PVC and the north end is 4 inch schedule 40 PVC.	40' from 2-G3-NE
2-G5	Shredded tires with pipe at the ends. The north end is 40 feet of 4 inch schedule 40 PVC. The south end is 40 feet of 4 inch schedule 80 PVC, 20 feet of 3 inch schedule 80 PVC, 20 feet of 4 inch schedule 80 PVC, and 10 feet of 12 inch corrugated HDPE[3].	40' from 2-G4-NE
3-G1	Shredded tires with PVC pipe at the ends. The north end is 40 feet of 4 inch schedule 40 PVC. The south end is 40 feet 4 inch schedule 80 and 20 feet of 8 inch schedule 40.	45' from west toe
3-G2	Shredded tires with PVC pipe at the ends. The north end is 40 feet of 4 inch schedule 40 VC. The south end is 40 feet of 4 inch schedule 80 PVC, 20 feet of 8 inch HDPE, and 40 feet of 6 inch HDPE.	45' from 3-G1-NE
3-G3	Shredded tires with PVC pipe at the ends. The north end is 40 feet of 4 inch schedule 40 PVC. The south end is 40 feet of 4 inch schedule 80 PVC, 20 feet of 6 inch schedule 40 PVC, and 10 feet of 12 inch corrugated HDPE.	35' from 3-G2-NE

[1]Gas Collection Line Nomenclature: Layer # - G (for gas) and gas line #
[2]Polyvinyl chloride, PVC
[3]High Density Polyethylene, HDPE

Table 4-1. Summary of Data for the West-Side Anaerobic Cell

Description	Data
Footprint	6 acres
Average Waste Depth	35 feet
Construction of the Base Liner	1999
Waste Filling of Cells	3/8/2001 – 8/31/2002
Total # of Waste Lifts	4
Total Amount of Waste	166,294 tons
Total Amount of Greenwaste ADC[1]	27,570 tons
Initial Volume of Cell	324,209 cubic yards
Estimated quantity of soil (2' cover over 6 acres)	9,680
Average Density of Waste	1,057 pounds per cubic yard (does not include soil or ADC)
Ratio of Waste to ADC	6 to 1
Total # of Horizontal Gas Collection Lines[2] Layer 1 Layer 2 Layer 3 Layer 4	18 Spacing of approximately 0 80 feet on center 9 (Layer 4 spacing of 7 approximately 50 feet) 2
Total # of Liquid Addition Lines (HDPE Pipe)[3] Layer 1 Layer 2 Layer 3 Layer 4	27 Spacings vary 0 17 7 3
Total Amount of Liquid Addition Piping Layer 1 Layer 2 Layer 3 Layer 4	7,185 feet 0 feet 4,350 feet 1,185 feet 1,650 feet
Total # of 3/32 and 1/8 inch Diameter Holes in Injection Line Layer 1 Layer 2 Layer 3 Layer 4	321 0 122 62 137
Surface Liner	40-mil[4] LLDPE[5] geomembrane

[1]ADC-Alternative Daily Cover
[2]Refer to Table 3 for a complete description of gas collection lines
[3]High Density Polyethylene, HDPE
[4]1-mil is equivalent to 0.001 inches and refers to the thickness of the liner
[5] Linear Low Density Polyproplyene Table 4-2. Summary of Gas Collection Lines for the West-Side Anaerobic Cell

Table 4-2. Summary of Gas Collection Lines for the West-Side Anaerobic Cell

Gas Collection Line[1]	Description	Spacing
2-G1	Shredded tires with pipe at ends. The east end is 45 feet of 4 inch schedule 80 PVC[2], 10 feet of 6 inch schedule 80 PVC, and 10 feet of 4 inch schedule 80 PVC. The west end is 50 feet of 4 inch schedule 80 PVC, 10 feet of 6 inch schedule 80 PVC, and 10 feet of 4 inch schedule 80 PVC.	80’ from 2-G2
2-G2	Shredded tires with pipe at ends. The east end is 40 feet of 4 inch schedule 40 PVC, 10 feet of 6 inch schedule 80 PVC, and 10 feet of 4 inch schedule 80 PVC. The west end is 40 feet of 4 inch schedule 40 PVC, 10 feet of 6 inch schedule 80 PVC, and 10 feet of 4 inch schedule 80 PVC.	80’from 2-G3
2-G3	Shredded tires with pipe on ends. The east and west ends are 40 feet of 4 inch schedule 80 PVC, 10 feet of 6 inch schedule 80 PVC, 10 feet of 4 inch schedule 80 PVC, 10 feet of 6 inch schedule 80 PVC, and 10 feet of 4 inch schedule 80 PVC.	80’ from 2-G4
2-G4	Shredded tires with pipe on ends. The east end is 20 feet of 4 inch schedule 80 PVC, 10 feet of 6 inch schedule 80 PVC, 10 feet of 4 inch schedule 80 PVC, 10 feet of 6 inch schedule 80 PVC, and 10 feet of 4 inch schedule 80 PVC. The west end is 20 feet of 4 inch schedule 80 PVC, 10 feet of 6 inch schedule 80 PVC, 10 feet of 4 inch schedule 80 PVC, 10 feet of 6 inch schedule 80 PVC, 10 feet of 4 inch schedule 80 PVC, and 20 feet of 24 inch corrugated metal pipe.	80’ from 2-G5
2-G5	Alternating 10-foot lengths of 4 inch schedule 40 electrical conduit and 6 inch corrugated metal. The east end is 40 feet of 4 inch schedule 40 PVC, 10 feet of 6 inch schedule 80 PVC, and 10 feet of 4 inch schedule 80 PVC. The west end is 40 feet of schedule 80 PVC and 10 feet of 6 inch schedule 40 electrical conduit.	80’from 2-G6
2-G6	Shredded tires with pipe at ends. The east end is 40 feet of 4 inch schedule 40 PVC, 10 feet of 6 inch schedule 80 PVC, and 10 feet of 4 inch schedule 80 PVC. The west end is 40 feet of 4 inch schedule 40 PVC, 10 feet of 12 inch schedule 40 PVC, 10 feet of 4 inch schedule 80 PVC, 10 feet of 12 inch schedule 40 PVC, and 10 feet of 4 inch schedule 80 PVC.	80’ from 2-G7
2-G7	Shredded tires with pipe on ends. The east end is 40 feet of 4 inch schedule 40 PVC, 10 feet of 6 inch schedule 80 PVC, and 10 feet of 4 inch schedule 80 PVC. The west end is 40 feet of 4 inch schedule 80 PVC, 10 feet of 6 inch schedule 80 PVC, and six sets of alternating 10 foot lengths of 4 inch schedule 80 PVC telescoped with 12 inch schedule 40 PVC.	80’from 2-G8
2-G8	Same as 2-G2	80’ from 2-G9
2-G9	Same as 2-G2	40’from south toe
3-G1	Shredded tires with pipe on west end. No pipe on east end. The west end is 40 feet of 4 inch schedule 80 PVC, and three sets of alternating 10 foot lengths of 6 inch schedule 80 PVC telescoped with 4 inch schedule 80 PVC.	80’ from 3-G2
3-G2	Same as 3-G1	80’ from 3-G3
3-G3	Same as 3-G1	80’ from 3-G4
3-G4	Same as 3-G1	80’ from 3-G5
3-G5	Same as 3-G1	80’ from 3-G6
3-G6	Shredded tires with pipe on west end. No pipe on east end. The west end is 50 feet of 4 inch schedule 80 PVC, and 60 feet of alternating 10 foot lengths of 6 inch and 4 inch schedule 80 PVC.	80’ from 3-G7
3-G7	Same as 3-G1	40’ from south toe
4-G1	Shredded tires with pipe on ends. The north and south ends are 3 sets of alternating 10 foot lengths of 6 inch schedule 80 PVC and 6 inch schedule 40 PVC, and one additional10 foot length of 6 inch schedule 80 PVC.	40’ from south toe
4-G2	Same as 4-G1	50’ from 4-G1

[1]Gas Collection Line Nomenclature: Layer #-G (for gas) and line #
[2]Polyvinyl chloride, PVC

Table 5-1. Summary of Data for the Aerobic Cell

Description	**Data**
Footprint	2.3 acres
Average Waste Depth	30 feet
Construction of the Base Liner	August 2001
Waste Filling of Cells	8/8/2001 – 9/26/2001
Total # of Waste Lifts	3
Total Amount of Waste	11,942 tons
Total Amount of Greenwaste ADC[1]	2,169 tons
Initial Volume of Cell	35,529 cubic yards
Estimated quantity of soil (1' cover over 56494 square feet)	2,092 cubic yards
Average Density of Waste	714 pounds per cubic yard (does not include soil or ADC)
Ratio of Waste to ADC	5.5 to 1
Total # of Corrugated Metal Pipe Horizontal Air Collection Lines Layer 1 Layer 2	6 Spacings vary. 3 3
Total # of CPVC[2] Pipe Horizontal Air Collection Lines Layer 1 Layer 2	5 Spacings vary. 3 2
Total Amount of Air Collection Lines[3] Layer 1 Layer 2	1,660 feet 1,100 feet 560 feet
Total # of HDPE[4] Pipe Liquid Addition Lines Layer 1 Layer 2 Layer 3	21 Spacings approximately 10 40 feet on center to 8 alternate with CPVC pipe 3 for liquid addition lines.
Total # of CPVC Pipe Liquid Addition Lines Layer 1 Layer 2	11 Spacings of approximately 6 40 feet on center to alternate 5 with HDPE pipe for liquid addition lines.
Total Amount of Liquid Addition Piping Layer 1 Layer 2 Layer 3	4,780 feet 2,870 feet 1,400 feet 510 feet
Total # of 3/32 inch Diameter Holes in Injection Lines Layer 1 Layer 2 Layer 3	326 186 97 43

[1]ADC-Alternative Daily Cover
[2]Chlorinated Polyvinyl Chloride, CPVC
[3]Refer to table A for a complete description of air collection lines
[4]High Density Polyethylene, HDPE

Table 5-2. Summary of Sensors for the Aerobic Cell

Type of Instrumentation	FPA Proposed Location/Quantity/Spacing	Aerobic Cell Actual Location/Quantity/Spacing
Pressure Transducers	1. Two over the primary liner at 200 feet spacing 2. One within the leachate collection sump	1. Two over the primary liner at 200 feet spacing 2. One within the leachate collection sump
Bubbler Gage for Liquid/Gas Pressure Measurement and Liquid/Gas Sampling	1. Top of the aerobic bottom liner-48 gages at 50 feet spacing 2. Top of the first lift of waste- 24 gages 3. Top of the second lift of waste-20 gages 4. Top of the final lift of waste-20 gages TOTAL= 112 gages	1. Top of the aerobic bottom liner-12 gages at 75 feet spacing 2. Top of the first lift of waste- 26 gages 3. Top of the second lift of waste- 16 gages 4. Top of the final lift of waste- no gages TOTAL= 54 gages
Moisture and Temperature Sensors	1. Top of the aerobic bottom liner-48 temperature and 12 moisture sensors 2. Between bottom liner and the top of the first lift of waste- no sensors 3. Top of the first lift of waste- 24 temperature and moisture sensors 4. Top of the second lift of waste-20 temperature and moisture sensors 5. Top of the final lift of waste-20 temperature and moisture sensors	1. Top of the aerobic bottom liner-12 temperature and 2 moisture sensors at 75 feet spacing 2. Between bottom liner and the top of the first lift of waste- 3 temperature sensors and 3 moisture sensors at various spacings. 3. Top of the first lift of waste- 26 temperature and 26 moisture sensors at various spacings 4. Top of the second lift of waste-18 temperature and 21 moisture sensors at various spacings 5. Top of the final lift of waste-no temperature or moisture sensors
	TOTAL= 112 temperature sensors and 76 moisture sensors	TOTAL= 59 temperature sensors and 52 moisture sensors

Table 5-3. Summary of Air Collection Lines for the Aerobic Cell

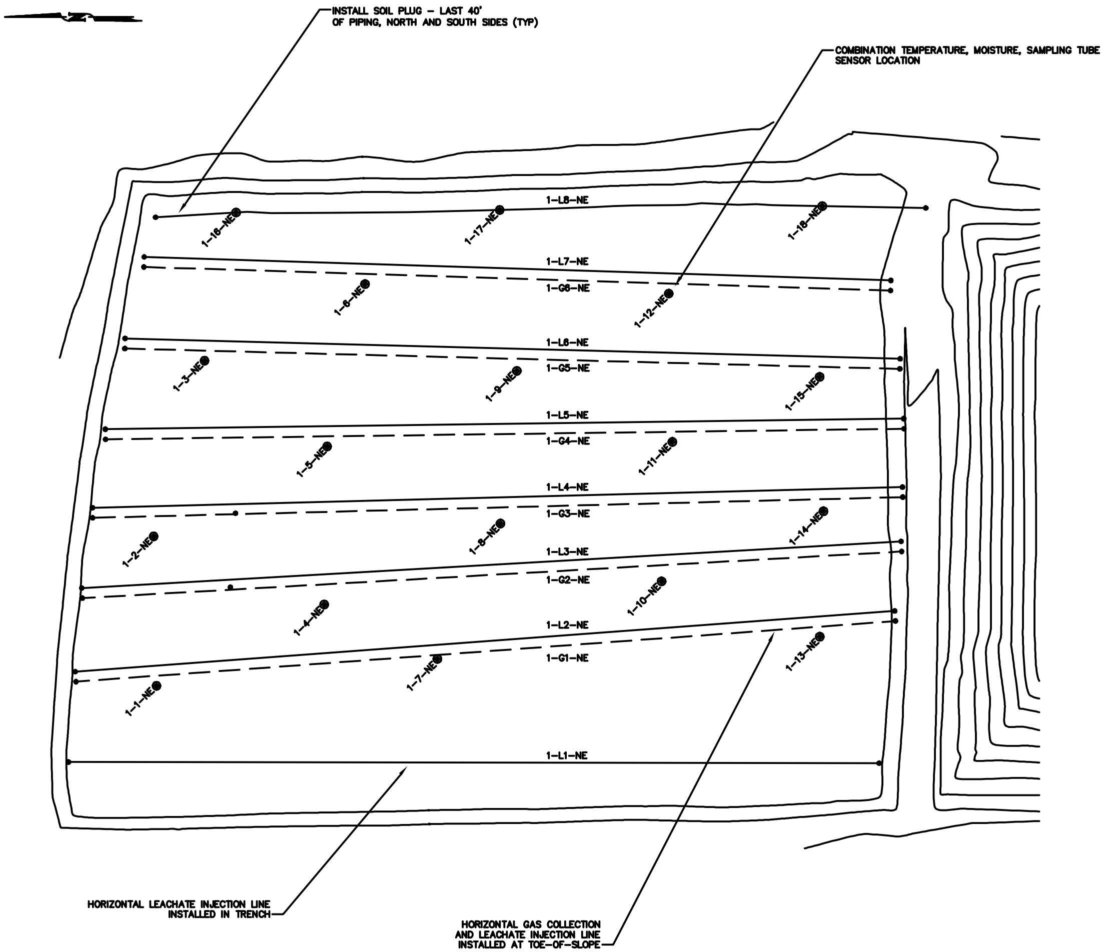
Air Collection Line[1]	Description	Spacing
1-A1	Alternating 10 foot lengths of 4 and 6 inch schedule 80 CPVC[2].	30' from west toe
1-A2	Alternating 10 foot lengths of 6 and 8 inch corrugated metal pipe.	40' from 1-A1-SE
1-A3	Alternating 10 foot lengths of 6 and 8 inch corrugated metal pipe.	40' from 1-A2-SE
1-A4	Alternating 10 foot lengths of 4 and 6 inch schedule 80 CPVC.	40' from 1-A3-SE
1-A5	Alternating 10 foot lengths of 6 and 8 inch corrugated metal pipe.	40' from 1-A4-SE
1-A6	Alternating 10 foot lengths of 4 and 6 inch schedule 80 CPVC.	40' from 1-A5-SE
2-A1	Alternating 10 foot lengths of 6 and 8 inch corrugated metal pipe.	25' from west toe
2-A2	Alternating 10 foot lengths of 4 and 6 inch schedule 80 CPVC.	40' from 2-A1-SE
2-A3	Alternating 10 foot lengths of 6 and 8 inch corrugated metal pipe.	40' from 2-A2-SE
2-A4	Alternating 10 foot lengths of 4 and 6 inch schedule 80 CPVC.	40' from 2-A3-SE
2-A5	Alternating 10 foot lengths of 6 and 8 inch corrugated metal pipe.	40' from 2-A4-SE

[1]Air Collection Line Nomenclature: Layer # - A (for air) and air collection line #
[2]Chlorinated Polyvinyl Chloride, PVC

Table 6-1. Summary of Sensors for the Module 6D Base Liner

Type of Instrumentation	FPA Proposed Location/Quantity/Spacing	Module 6D Base Liner Actual Location/Quantity/Spacing
Pressure Transducer	1. Eight over the primary liner near the LCRS trench at 200 feet spacing 2. Two over the primary liner within the leachate collection sumps	1. Six over the primary liner at 200 feet spacing (three near the west LCRS and three near the east LCRS) 2. Four over the primary liner within the leachate collection sumps
Bubbler Gage for Liquid/Gas Pressure Measurement and Liquid/Gas Sampling	Top of primary bottom liner-66 gages at 75 feet spacing	Top of primary bottom liner-66 gages at 75 feet spacing
Moisture and Temperature Sensors	Top of primary bottom liner-66 temperature sensors at 75 feet spacing and 12 moisture sensors	Top of primary bottom liner-66 temperature sensors at 75 feet spacing and 12 moisture sensors

APPENDIX B – PIPING AND INSTRUMENTATION PLAN



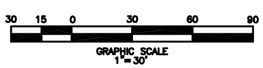
MONITORING POINT COORDINATES			
SENSOR DESIGNATION	NORTHING	EASTING	ELEVATION (MSL)
1–1–NE	1980055	6651259	40
1–2–NE	1980057	6651433	39
1–3–NE	1980031	6651520	39.5
1–4–NE	1979972	6651399	39.5
1–5–NE	1979971	6651478	39
1–6–NE	1979952	6651588	40.5
1–7–NE	1979916	6651372	40
1–8–NE	1979885	6651440	39
1–9–NE	1979876	6651515	39.5
1–10–NE	1979805	6651411	39.5
1–11–NE	1979799	6651480	39
1–12–NE	1979801	6651554	40.5
1–13–NE	1979726	6651383	40
1–14–NE	1979724	6651446	39
1–15–NE	1979726	6651512	39.5
1–16–NE	1980016	6651594	40
1–17–NE	1979885	6651595	40
1–18–NE	1979725	6651597	40

LEGEND

— — — — (dashed line)	HORIZONTAL LEACHATE INJECTION LINE,1.25" ø, SDR 11 HDPE WITH 3/32" ø DRILLED HOLES @ 20' O/C
——— (solid line)	HORIZONTAL GAS COLLECTION LINE, VARIOUS CONFIGURATIONS
●	THERMISTER, QUALITY THERMISTER NTC PROBE, 10,000 OHM RESISTANCE AT 25°C, TOLERANCE ±0.2°C (0–100°C), PRESSURE SENSING TUBE, 1/4–INCH ID BY 3/8 OD LLDPE, AND PVC MOISTURE SENSOR.
1–01–NE	LEVEL 1, INSTRUMENT LOCATION 1, NORTHEAST ANAEROBIC MODULE
1–L1–NE	LEVEL 1, LEACHATE INJECTION LINE 1, NORTHEAST ANAEROBIC MODULE
1–G1–NE	LEVEL 1, GAS EXTRACTION LINE 1, NORTHEAST MODULE

AS-BUILT

WARNING: THE ORIGINAL DOCUMENTS CONTAIN A RED COLORED PROFESSIONAL SEAL AND BLACK SIGNATURE.



NO.	REVISIONS DESCRIPTIONS	DATE	APPV

YOLO COUNTY
DEPARTMENT OF PLANNING & PUBLIC WORKS
DIVISION OF INTEGRATED WASTE MANAGEMENT
292 WEST BEAMER ST., WOODLAND, CA 95695

ASSISTANT DIRECTOR OF PUBLIC WORKS

APPROVED ____________ 19 ______ ____________ R. E. NO.

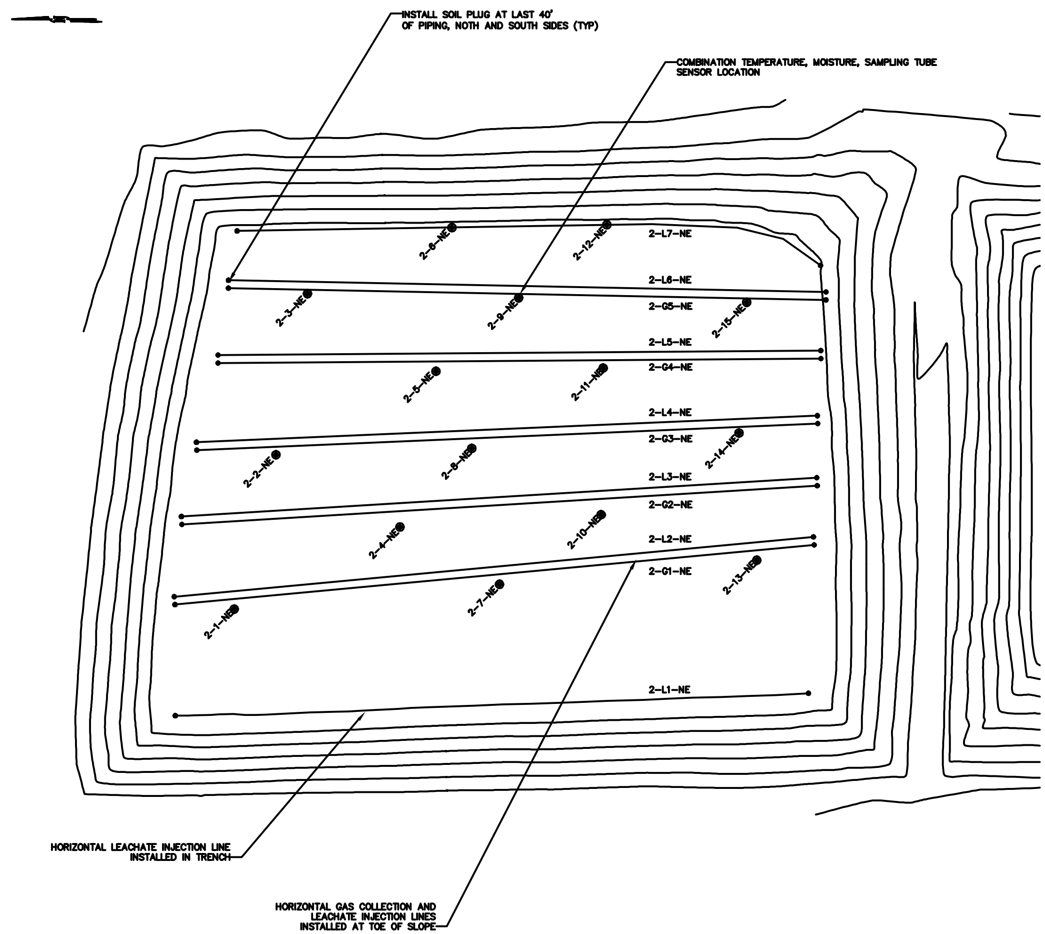
YOLO COUNTY CENTRAL LANDFILL
FULL–SCALE BIOREACTOR

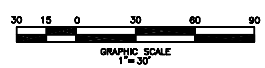
NE ANAEROBIC MODULE LEVEL 1 PIPING AND INSTRUMENTATION

DRAWING NO. ____________

W.O. NO.	9207
F.B. NO.	T.9N.R.3E.
DESIGN BY	JDK
DRAWN BY	JDK
CHECKED BY	RY
FILE NAME	
DATE	8/6/02

DETAIL
3–2





SENSOR DESIGNATION	NORTHING	EASTING	ELEVATION (MSL)
2-1-NE	1980027	6651382	54
2-2-NE	1980006	6651460	52.5
2-3-NE	1979990	6651541	49.5
2-4-NE	1979944	6651423	53
2-5-NE	1979925	6651502	51
2-6-NE	1979917	6651574	49.5
2-7-NE	1979893	6651394	54
2-8-NE	1979907	6651463	52.5
2-9-NE	1979884	6651539	49.5
2-10-NE	1979842	6651430	53
2-11-NE	1979841	6651503	51
2-12-NE	1979839	6651576	49.5
2-13-NE	1979764	6651407	54
2-14-NE	1979772	6651471	52.5
2-15-NE	1979769	6651537	49.5

LEGEND

HORIZONTAL LEACHATE INJECTION LINE,1.25" ø, SDR 11 HDPE WITH 3/32" ø DRILLED HOLES @ 20' O/C

HORIZONTAL GAS COLLECTION LINE, VARIOUS CONFIGHURATIONS

● THERMISTER, QUALITY THERMISTER NTC PROBE, 10,000 OHM RESISTANCE AT 25°C, TOLERANCE ±0.2°C (0–100°C), PRESSURE SENSING TUBE, 1/4-INCH ID BY 3/8 OD LLDPE, AND PVC MOISTURE SENSOR.

2-O1-NE LEVEL 2, INSTRUMENT LOCATION 1, NORTHEAST ANAEROBIC MODULE

2-L1-NE LEVEL 2, LEACHATE INJECTION LINE 1, NORTHEAST ANAEROBIC MODULE

2-G1-NE LEVEL 2, GAS EXTRACTION LINE 1, NORTHEAST MODULE

AS-BUILT

WARNING: THE ORIGINAL DOCUMENTS CONTAIN A RED COLORED PROFESSIONAL SEAL AND BLACK SIGNATURE.

NO.	REVISIONS DESCRIPTIONS	DATE	APPV

YOLO COUNTY
DEPARTMENT OF PLANNING & PUBLIC WORKS
DIVISION OF INTEGRATED WASTE MANAGEMENT
292 WEST BEAMER ST., WOODLAND, CA 95695

ASSISTANT DIRECTOR OF PUBLIC WORKS

APPROVED ____ 19 ____ R. E. NO.

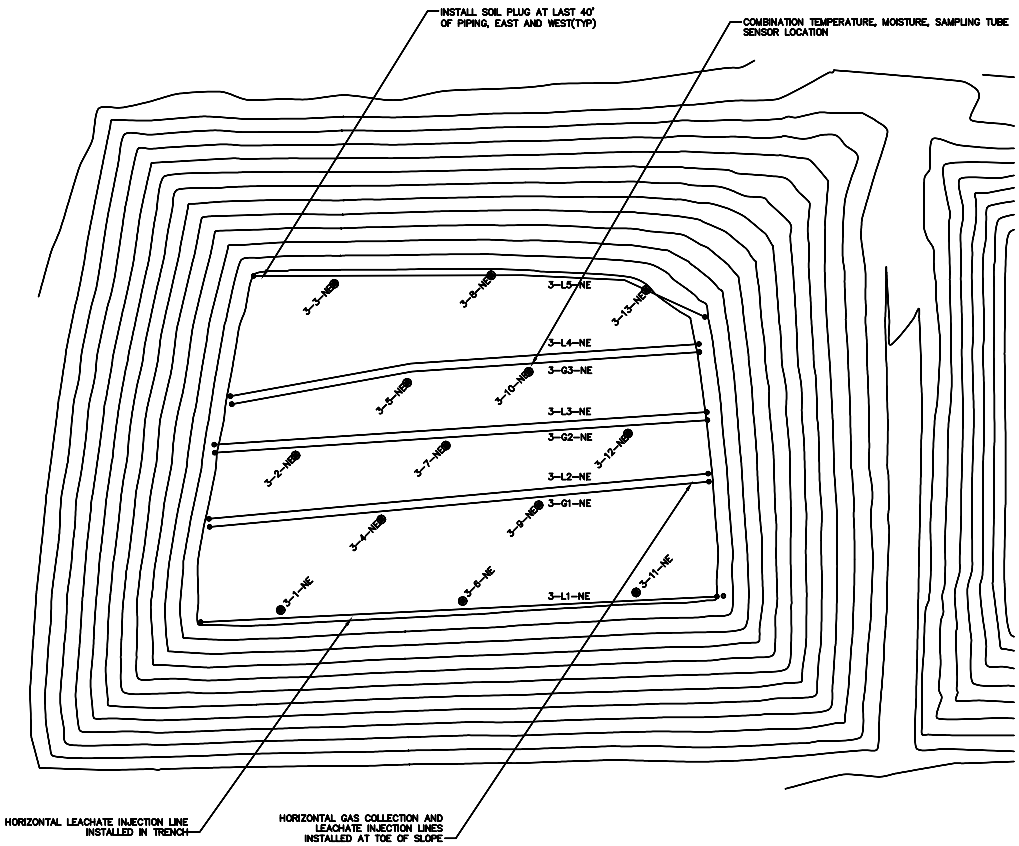
YOLO COUNTY CENTRAL LANDFILL
FULL-SCALE BIOREACTOR

NE ANAEROBIC MODULE LEVEL 2 PIPING AND INSTRUMENTATION

DRAWING NO. ____

W.O. NO.	9207
F.B. NO.	T.9N.R.3E.
DESIGN BY	JDK
DRAWN BY	JDK
CHECKED BY	RY
FILE NAME	----
DATE	8/6/02

DETAIL
3-3

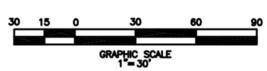


SENSOR DESIGNATION	NORTHING	EASTING	ELEVATION (MSL)
3-1-NE	1979983	6651367	65
3-2-NE	1979976	6651443	65
3-3-NE	1979957	6651528	64
3-4-NE	1979934	6651412	65.5
3-5-NE	1979921	6651479	64.5
3-6-NE	1979893	6651371	65
3-7-NE	1979902	6651448	65
3-8-NE	1979879	6651532	64
3-9-NE	1979856	6651419	65.5
3-10-NE	1979861	6651485	64.5
3-11-NE	1979808	6651376	65
3-12-NE	1979812	6651454	65
3-13-NE	1979803	6651525	64

LEGEND

(line)	HORIZONTAL LEACHATE INJECTION LINE, 1.25" ø, SDR 11 HDPE WITH 3/32" ø DRILLED HOLES @ 20' O/C
(line)	HORIZONTAL GAS COLLECTION LINE, VARIOUS CONFIGHURATIONS
●	THERMISTER, QUALITY THERMISTER NTC PROBE, 10,000 OHM RESISTANCE AT 25°C, TOLERANCE ±0.2°C (0-100°C), PRESSURE SENSING TUBE, 1/4-INCH ID BY 3/8 OD LLDPE, AND PVC MOISTURE SENSOR.
3-01-NE	LEVEL 3, INSTRUMENT LOCATION 1, NORTHEAST ANAEROBIC MODULE
3-L1-NE	LEVEL 3, LEACHATE INJECTION LINE 1, NORTHEAST ANAEROBIC MODULE
3-G1-NE	LEVEL 3, GAS EXTRACTION LINE 1, NORTHEAST MODULE

AS-BUILT



WARNING: THE ORIGINAL DOCUMENTS CONTAIN A RED COLORED PROFESSIONAL SEAL AND BLACK SIGNATURE.

NO.	REVISIONS DESCRIPTIONS	DATE	APPV

YOLO COUNTY
DEPARTMENT OF PLANNING & PUBLIC WORKS
DIVISION OF INTEGRATED WASTE MANAGEMENT
292 WEST BEAMER ST., WOODLAND, CA 95695

ASSISTANT DIRECTOR OF PUBLIC WORKS

APPROVED ____________ 19 ______ R. E. NO. ______

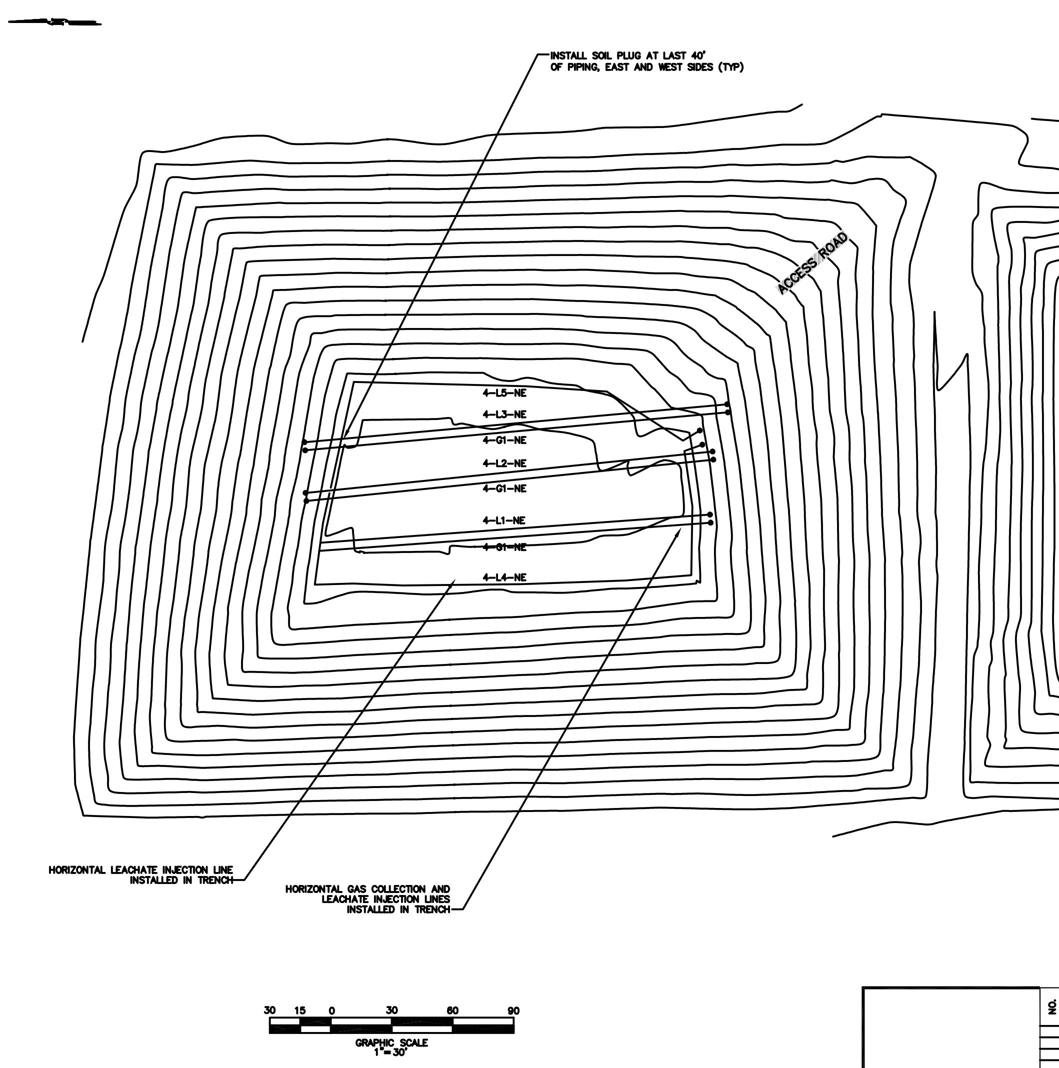
YOLO COUNTY CENTRAL LANDFILL
FULL-SCALE BIOREACTOR

NE ANAEROBIC MODULE LEVEL 3 PIPING AND INSTRUMENTATION

DRAWING NO. ______

W.O. NO.	9207
F.B. NO.	T.9N.R.3E.
DESIGN BY	JDK
DRAWN BY	JDK
CHECKED BY	RY
FILE NAME	——
DATE	8/6/02

DETAIL 3-4



LEGEND

———	HORIZONTAL LEACHATE INJECTION LINE,1.25" ø, SDR 11 HDPE WITH 3/32" ø DRILLED HOLES @ 20' O/C
———	HORIZONTAL GAS COLLECTION LINE, VARIOUS CONFIGHURATIONS
4-L1-NE	LEVEL 4, LEACHATE INJECTION LINE 1, NORTHEAST ANAEROBIC MODULE
4-G1-NE	LEVEL 4, GAS EXTRACTION LINE 1, NORTHEAST MODULE

AS-BUILT

WARNING: THE ORIGINAL DOCUMENTS CONTAIN A RED COLORED PROFESSIONAL SEAL AND BLACK SIGNATURE.

NO.	REVISIONS DESCRIPTIONS	DATE	APPV

YOLO COUNTY
DEPARTMENT OF PLANNING & PUBLIC WORKS
DIVISION OF INTEGRATED WASTE MANAGEMENT
292 WEST BEAMER ST., WOODLAND, CA 95695

ASSISTANT DIRECTOR OF PUBLIC WORKS

APPROVED ________ 19 ____ R. E. NO.

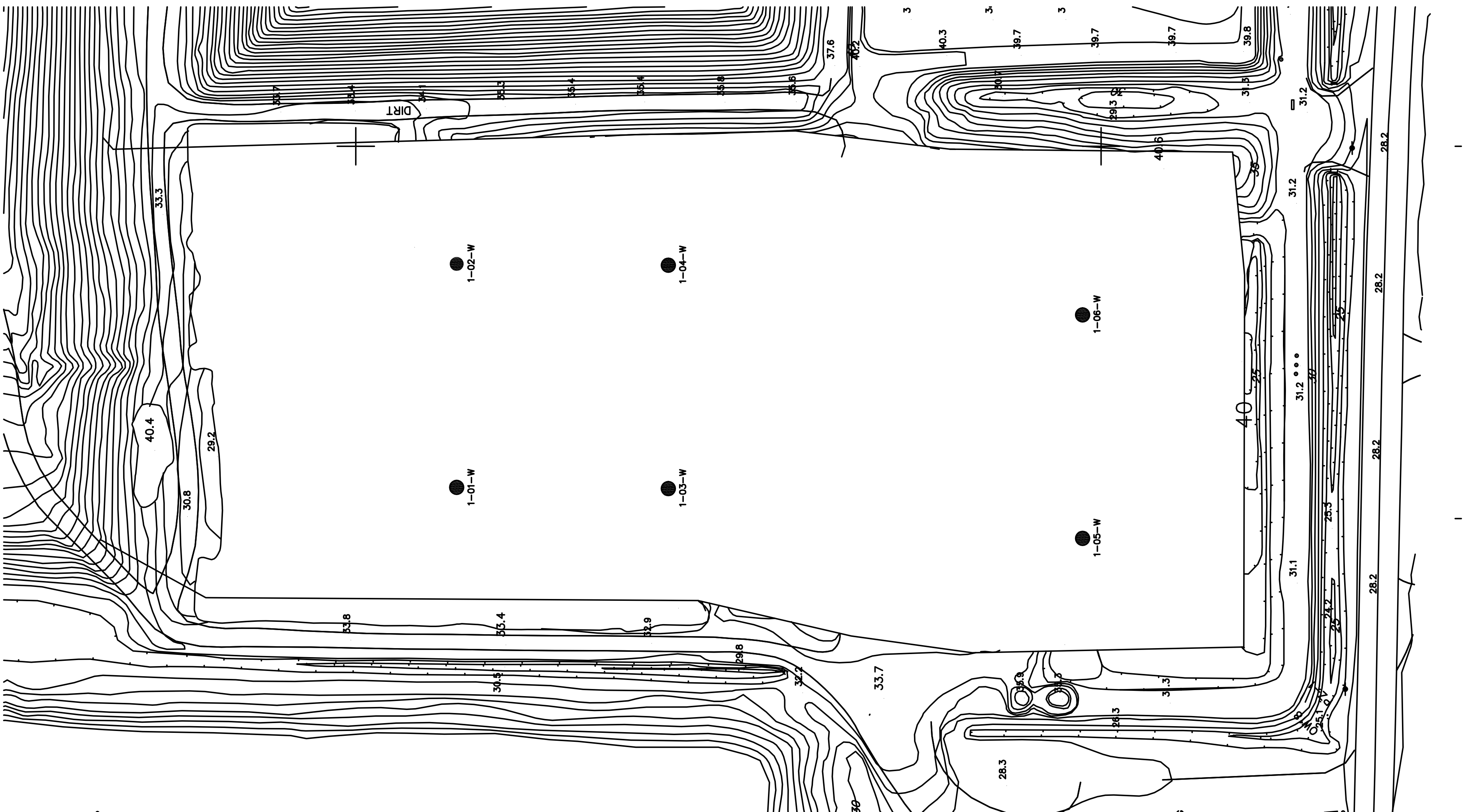
YOLO COUNTY CENTRAL LANDFILL
FULL-SCALE BIOREACTOR

NE ANAEROBIC MODULE LEVEL 4 PIPING AND INSTRUMENTATION

DRAWING NO.

W.O. NO.	9207
F.B. NO.	T.9N.R.3E.
DESIGN BY	JDK
DRAWN BY	JDK
CHECKED BY	RY
FILE NAME	——
DATE	8/6/02

DETAIL 3-5



GRAPHIC SCALE
1"=30'

30 15 0 30 60 120

LEGEND

● THERMISTER, QUALITY THERMISTER NTC PROBE, 10,000 OHM RESISTANCE AT 25°C, TOLERANCE ±0.2°C (0–100°C), AND PVC MOISTURE SENSOR.

1-01-W LEVEL 1, INSTRUMENT LOCATION 1, WEST ANAEROBIC MODULE

NO.	REVISIONS DESCRIPTIONS	DATE	APPV

YOLO COUNTY
DEPARTMENT OF PLANNING & PUBLIC WORKS
DIVISION OF INTEGRATED WASTE MANAGEMENT
292 WEST BEAMER ST., WOODLAND, CA 95695

ASSISTANT DIRECTOR OF PUBLIC WORKS

APPROVED ____________ 19 ______ R. E. NO. ______

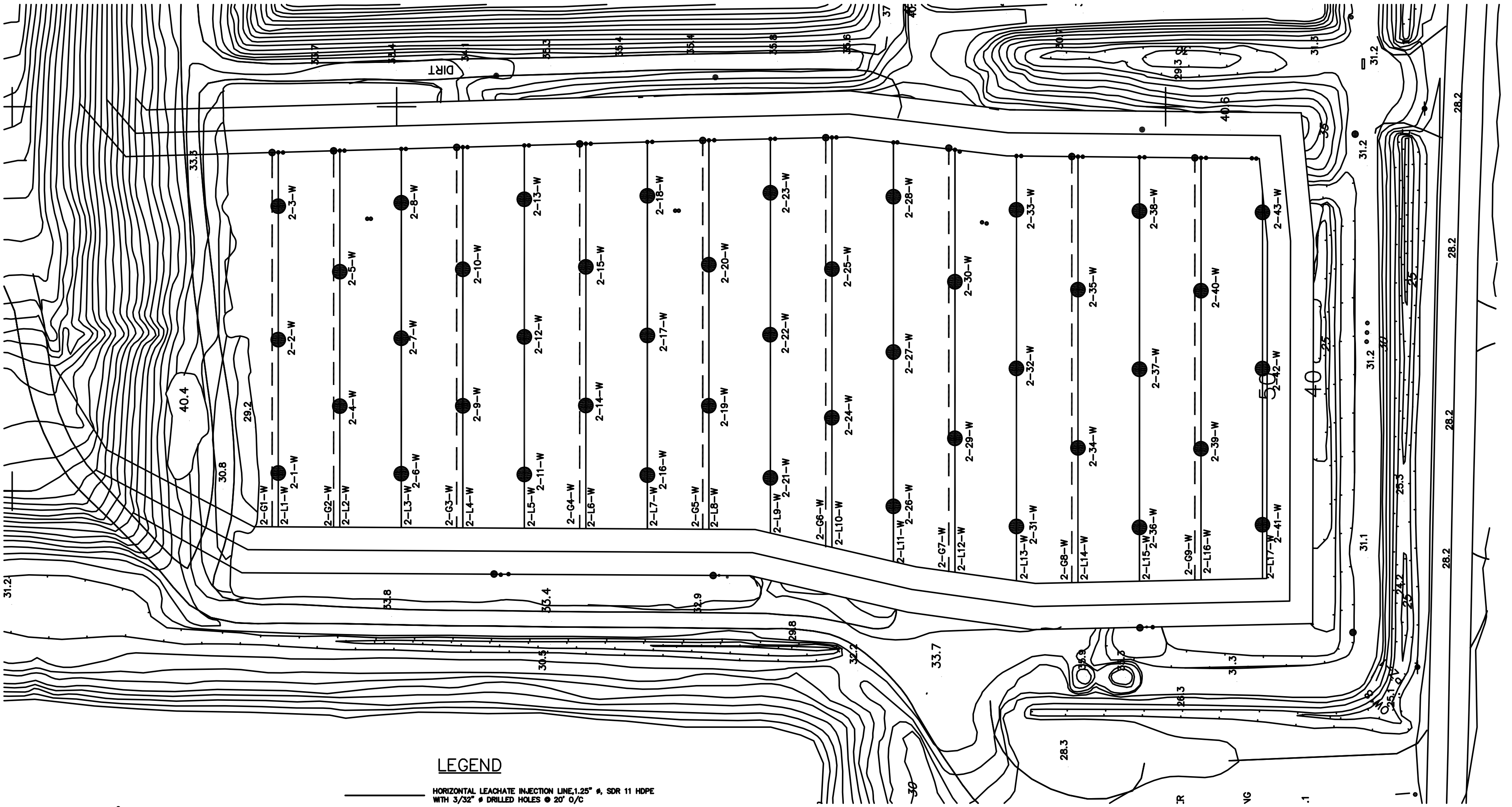
YOLO COUNTY CENTRAL LANDFILL

FULL SCALE BIOREACTOR WEST SIDE, LEVEL 1 PIPING AND INSTRUMENTATION PLAN

DRAWING NO. ______

W.O. NO. 9207
F.B. NO. T.9N.R.3E.
DESIGN BY JDK
DRAWN BY JDK
CHECKED BY XX
FILE NAME
DATE 2/21/02

DETAIL 4-2



LEGEND

(solid line)	HORIZONTAL LEACHATE INJECTION LINE,1.25" ø, SDR 11 HDPE WITH 3/32" ø DRILLED HOLES @ 20' O/C
(dashed line)	HORIZONTAL GAS COLLECTION LINE, VARIOUS CONFIGURATIONS
●	THERMISTER, QUALITY THERMISTER NTC PROBE, 10,000 OHM RESISTANCE AT 25°C, TOLERANCE ±0.2°C (0–100°C), AND PVC MOISTURE SENSOR.
2-01-W	LEVEL 2, INSTRUMENT LOCATION 1, WEST ANAEROBIC MODULE
2-L1-W	LEVEL 2, LEACHATE INJECTION LINE 1, WEST ANAEROBIC MODULE
2-G1-W	LEVEL 2, GAS EXTRACTION LINE 1, WEST ANAEROBIC MODULE

30 15 0 30 60 120

GRAPHIC SCALE
1"=30'

WARNING: THE ORIGINAL DOCUMENTS CONTAIN A RED COLORED PROFESSIONAL SEAL AND BLACK SIGNATURE.

NO.	REVISIONS / DESCRIPTIONS	DATE	APPV

YOLO COUNTY
DEPARTMENT OF PLANNING & PUBLIC WORKS
DIVISION OF INTEGRATED WASTE MANAGEMENT
292 WEST BEAMER ST., WOODLAND, CA 95695

ASSISTANT DIRECTOR OF PUBLIC WORKS

APPROVED ____________ 19 ______ R. E. NO. ____________

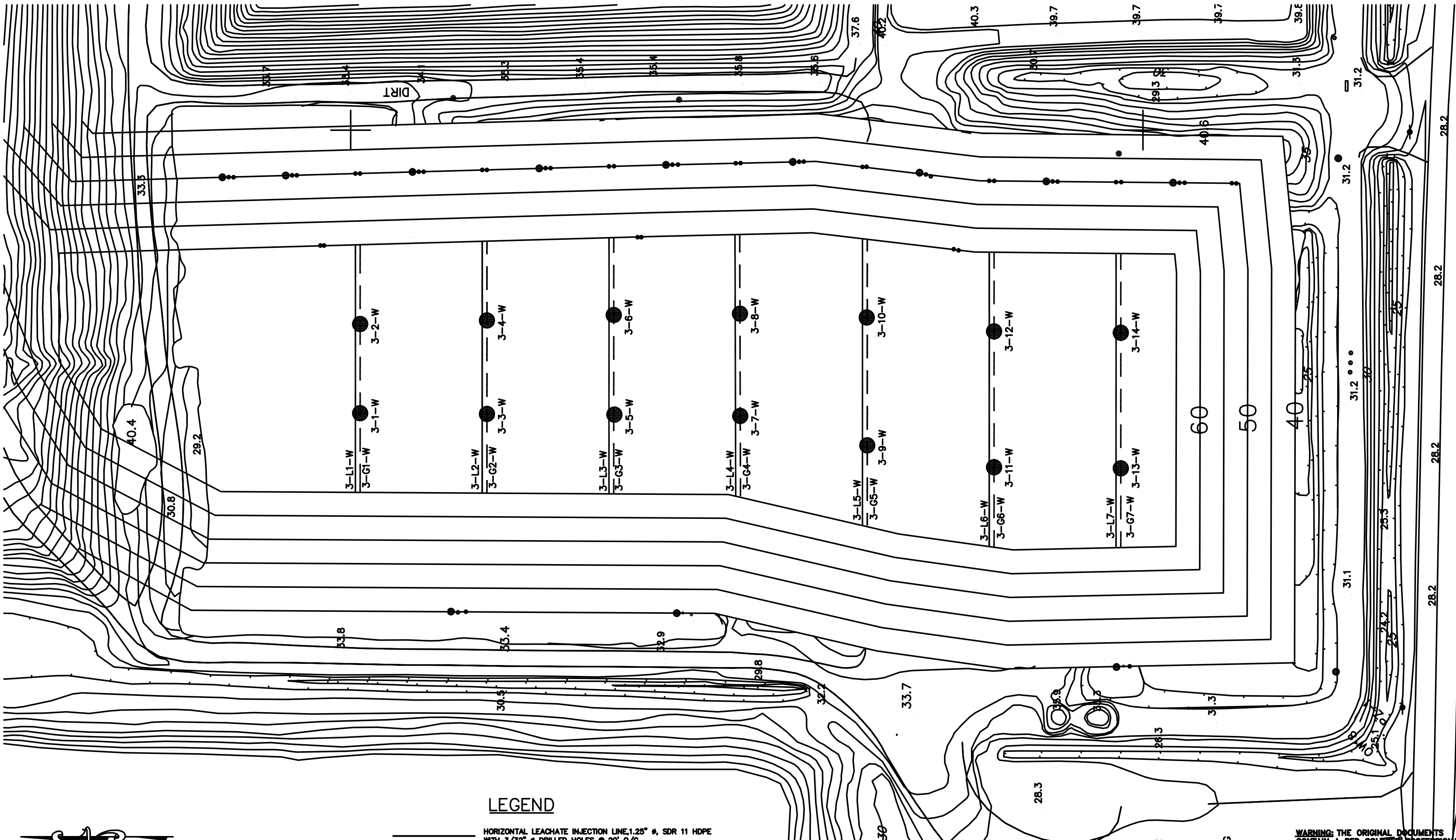
YOLO COUNTY CENTRAL LANDFILL

FULL SCALE BIOREACTOR WEST SIDE, LEVEL 2 PIPING AND INSTRUMENTATION PLAN

DRAWING NO. ____________

W.O. NO.	9207
F.B. NO.	T.9N.R.3E.
DESIGN BY	JDK
DRAWN BY	JDK
CHECKED BY	XX
FILE NAME	
DATE	2/21/02

DETAIL 4-3



LEGEND

HORIZONTAL LEACHATE INJECTION LINE,1.25" ø, SDR 11 HDPE WITH 3/32" ø DRILLED HOLES @ 20' O/C

HORIZONTAL GAS COLLECTION LINE, VARIOUS CONFIGURATIONS

THERMISTER, QUALITY THERMISTER NTC PROBE, 10,000 OHM RESISTANCE AT 25°C, TOLERANCE ±0.2°C (0–100°C), AND PVC MOISTURE SENSOR.

3-01-W LEVEL 3, INSTRUMENT LOCATION 1, WEST ANAEROBIC MODULE

3-L1-W LEVEL 3, LEACHATE INJECTION LINE 1, WEST ANAEROBIC MODULE

3-G1-W LEVEL 3, GAS EXTRACTION LINE 1, WEST ANAEROBIC MODULE

30 15 0 30 60 120

GRAPHIC SCALE
1" = 30'

WARNING: THE ORIGINAL DOCUMENTS CONTAIN A RED COLORED PROFESSIONAL SEAL AND BLACK SIGNATURE.

NO.	REVISIONS DESCRIPTIONS	DATE	APPV

YOLO COUNTY
DEPARTMENT OF PLANNING & PUBLIC WORKS
DIVISION OF INTEGRATED WASTE MANAGEMENT
292 WEST BEAMER ST., WOODLAND, CA 95695

ASSISTANT DIRECTOR OF PUBLIC WORKS

APPROVED ____________ 19 ______ ____________ R. E. NO.

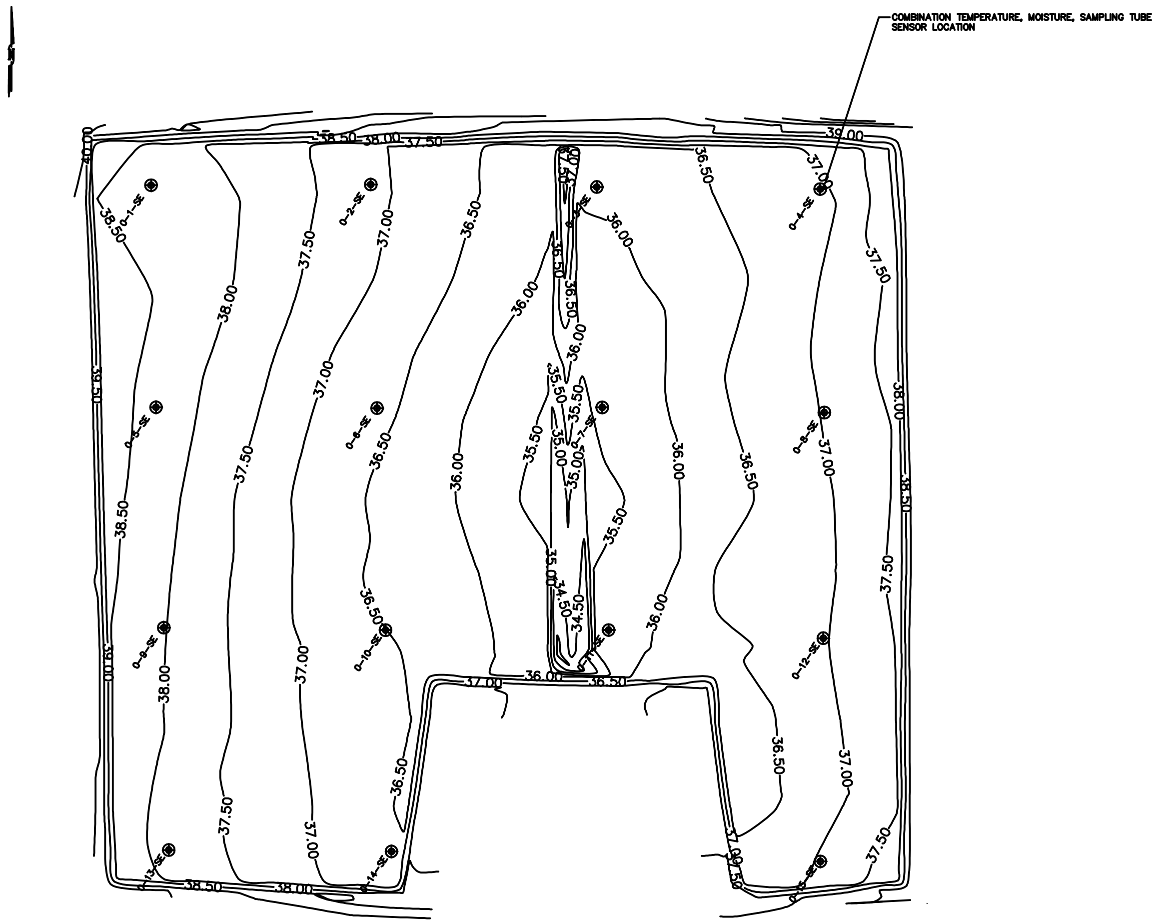
YOLO COUNTY CENTRAL LANDFILL

FULL SCALE BIOREACTOR WEST SIDE, LEVEL 3 PIPING AND INSTRUMENTATION PLAN

DRAWING NO. ____________

W.O. NO.	9207
F.B. NO.	T.9N.R.3E.
DESIGN BY	JDK
DRAWN BY	JDK
CHECKED BY	XX
FILE NAME	[illegible]
DATE	2/21/02

DETAIL 4-4



SENSOR DESIGNATION	NORTHING	EASTING	ELEVATION (MSL)
0-1-SE	1979642	6651322	38.4
0-2-SE	1979642	6651406	37
0-3-SE	1979642	6651482	36
0-4-SE	1979641	6651557	37
0-5-SE	1979567	6651334	38.2
0-6-SE	1979567	6651408	36.6
0-7-SE	1979567	6651484	35.5
0-8-SE	1979566	6651559	37
0-9-SE	1979493	6651336	38
0-10-SE	1979493	6651411	36.5
0-11-SE	1979493	6651486	35.6
0-12-SE	1979490	6651558	37
0-13-SE	1979419	6651338	37.9
0-14-SE	1979418	6651413	36.7
0-15-SE	1979415	6651557	37

LEGEND

● THERMISTER, QUALITY THERMISTER NTC PROBE, 10,000 OHM RESISTANCE AT 25°C, TOLERANCE ±0.2°C (0–100°C), PRESSURE SENSING TUBE, 1/4-INCH ID BY 3/8 OD LLDPE, AND, AT LOCATIONS 05, 07, 14, AND 15, A PVC MOISTURE SENSOR.

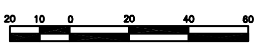
0-1-SE LEVEL 0, INSTRUMENT LOCATION 1, SOUTHEAST ANAEROBIC MODULE

NOTES

1. STRIPS OF GEOCOMPOSITE DRAIN NET PLACED UNDER LINER COOLING AND LINER COOLING/SETTLEMENT PIPES TO PROMOTE BETTER DRAINAGE INDER PIPES.

AS-BUILT

WARNING: THE ORIGINAL DOCUMENTS CONTAIN A RED COLORED PROFESSIONAL SEAL AND BLACK SIGNATURE.



GRAPHIC SCALE
1" = 20'

NO.	REVISIONS DESCRIPTIONS	DATE	APPV

YOLO COUNTY
DEPARTMENT OF PLANNING & PUBLIC WORKS
DIVISION OF INTEGRATED WASTE MANAGEMENT
292 WEST BEAMER ST., WOODLAND, CA 95695

ASSISTANT DIRECTOR OF PUBLIC WORKS

APPROVED ________ 19 ____ R. E. NO.

YOLO COUNTY CENTRAL LANDFILL
FULL-SCALE BIOREACTOR

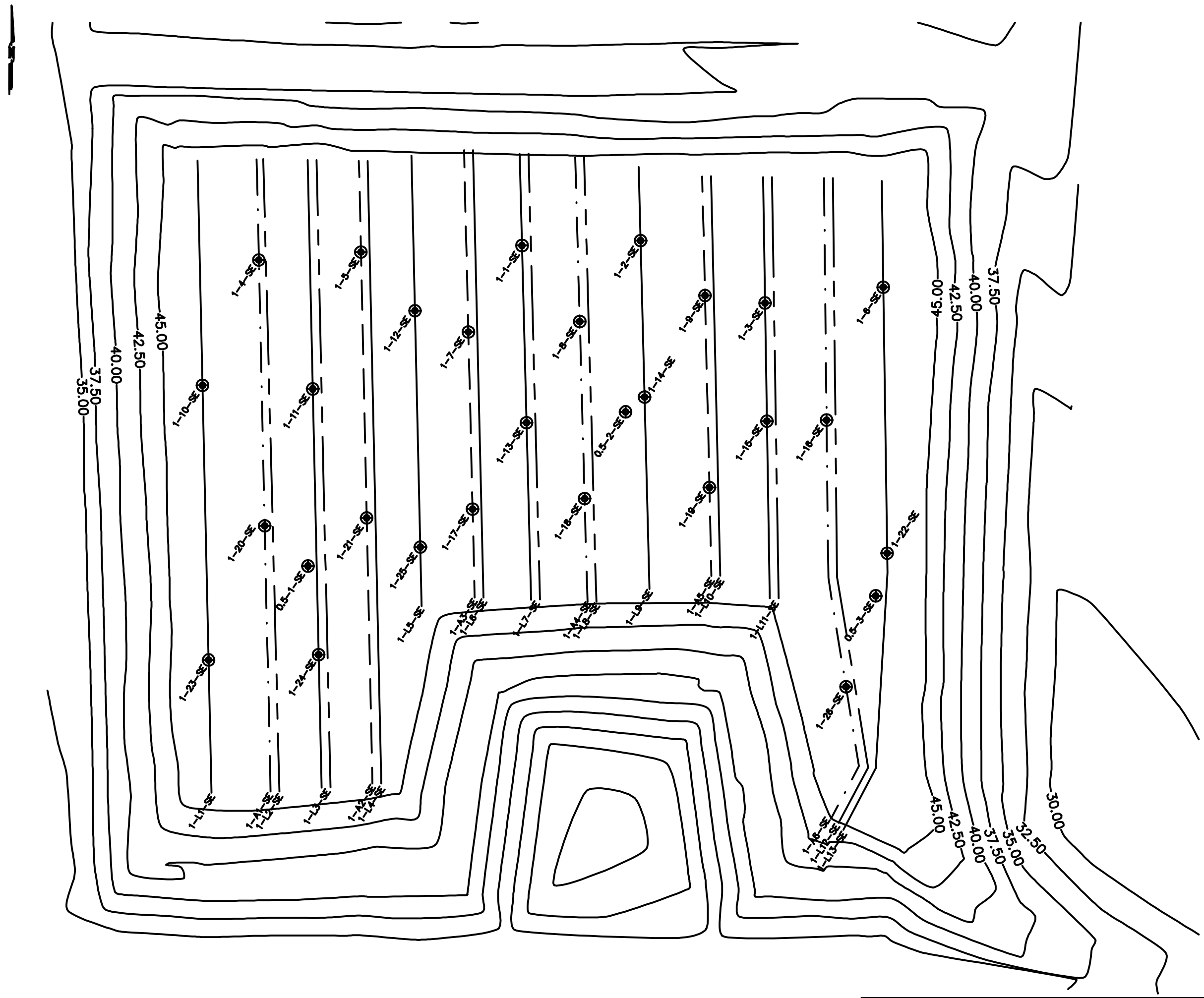
SE AEROBIC MODULE LEVEL 0 PIPING AND INSTRUMENTATION

DRAWING NO. ________

W.O. NO. 9207
F.B. NO. T.9N.R.3E.
DESIGN BY JDK
DRAWN BY JDK
CHECKED BY RY
FILE NAME ——
DATE 8/6/02

DETAIL 5-2

SENSOR DESIGNATION	NORTHING	EASTING	ELEVATION (MSL)
1-1-SE	1979615	6651443	42
1-2-SE	1979617	6651484	43
1-3-SE	1979596	6651526	46
1-4-SE	1979611	6651354	44.5
1-5-SE	1979613	6651389	44
1-6-SE	1979601	6651566	47
1-7-SE	1979586	6651425	42
1-8-SE	1979590	6651463	43
1-9-SE	1979599	6651505	46
1-10-SE	1979568	6651335	44.5
1-11-SE	1979567	6651373	44.5
1-12-SE	1979593	6651407	44
1-13-SE	1979555	6651445	42
1-14-SE	1979564	6651485	43
1-15-SE	1979556	6651526	46
1-16-SE	1979556	6651546	47
1-17-SE	1979526	6651427	42
1-18-SE	1979530	6651465	43
1-19-SE	1979534	6651507	46
1-20-SE	1979521	6651356	44.5
1-21-SE	1979523	6651391	44
1-22-SE	1979511	6651567	47
1-23-SE	1979475	6651337	44.5
1-24-SE	1979477	6651375	44.5
1-25-SE	1979513	6651409	44
1-26-SE	1979466	6651553	47
0.5-1-SE	1979507	6651371	41
0.5-2-SE	1979559	6651478	39.5
0.5-3-SE	1979497	6651563	41



LEGEND

HORIZONTAL LEACHATE INJECTION LINE,1.25" ø, SDR 11 HDPE WITH 3/32" ø DRILLED HOLES @ 10' O/C

HORIZONTAL LEACHATE INJECTION LINE,1.25" ø, SCHEDULE 80 CPVC WITH 3/32" ø DRILLED HOLES @ 10' O/C

HORIZONTAL AIR COLLECTION LINE, ALTERNATING 4 AND 6-INCH CPVC

HORIZONTAL AIR COLLECTION LINE, ALTERNATING 6 AND 8-INCH COORIGATED METAL PIPE WITH HDPE INJECTION LINE INSIDE.

THERMISTER, QUALITY THERMISTER NTC PROBE, 10,000 OHM RESISTANCE AT 25°C, TOLERANCE ±0.2°C (0-100°C), PRESSURE SENSING TUBE, 1/4-INCH ID BY 3/8 OD LLDPE, AND PVC MOISTURE SENSOR.

0.5-1-SE — LEVEL 0.5, INSTRUMENT LOCATION 1, SOUTHEAST ANAEROBIC MODULE

1-1-SE — LEVEL 1, INSTRUMENT LOCATION 1, SOUTHEAST ANAEROBIC MODULE

1-L1-SE — LEVEL 1, LEACHATE INJECTION LINE 1, SOUTHEAST ANAEROBIC MODULE

1-A1-SE — LEVEL 1, AIR COLLECTION LINE 1, SOUTHEAST MODULE

NOTES

1. ALL PIPING AND INSTRUMENTATION INSTALLED IN 3-FOOT WIDE BY 2-FOOT DEEP TRENCH. ALL TRENCHES WERE BACKFILLED WITH TIRES.
2. SENSORS DESIGNATED 0.5 WERE INSTALLED APPROXIMATELY 4-FEET ABOVE THE AEROBIC LINER.

AS-BUILT

WARNING: THE ORIGINAL DOCUMENTS CONTAIN A RED COLORED PROFESSIONAL SEAL AND BLACK SIGNATURE.

NO.	REVISIONS DESCRIPTIONS	DATE	APPV

YOLO COUNTY
DEPARTMENT OF PLANNING & PUBLIC WORKS
DIVISION OF INTEGRATED WASTE MANAGEMENT
292 WEST BEAMER ST., WOODLAND, CA 95695

ASSISTANT DIRECTOR OF PUBLIC WORKS

APPROVED ______ 19 ____ ______ R. E. NO.

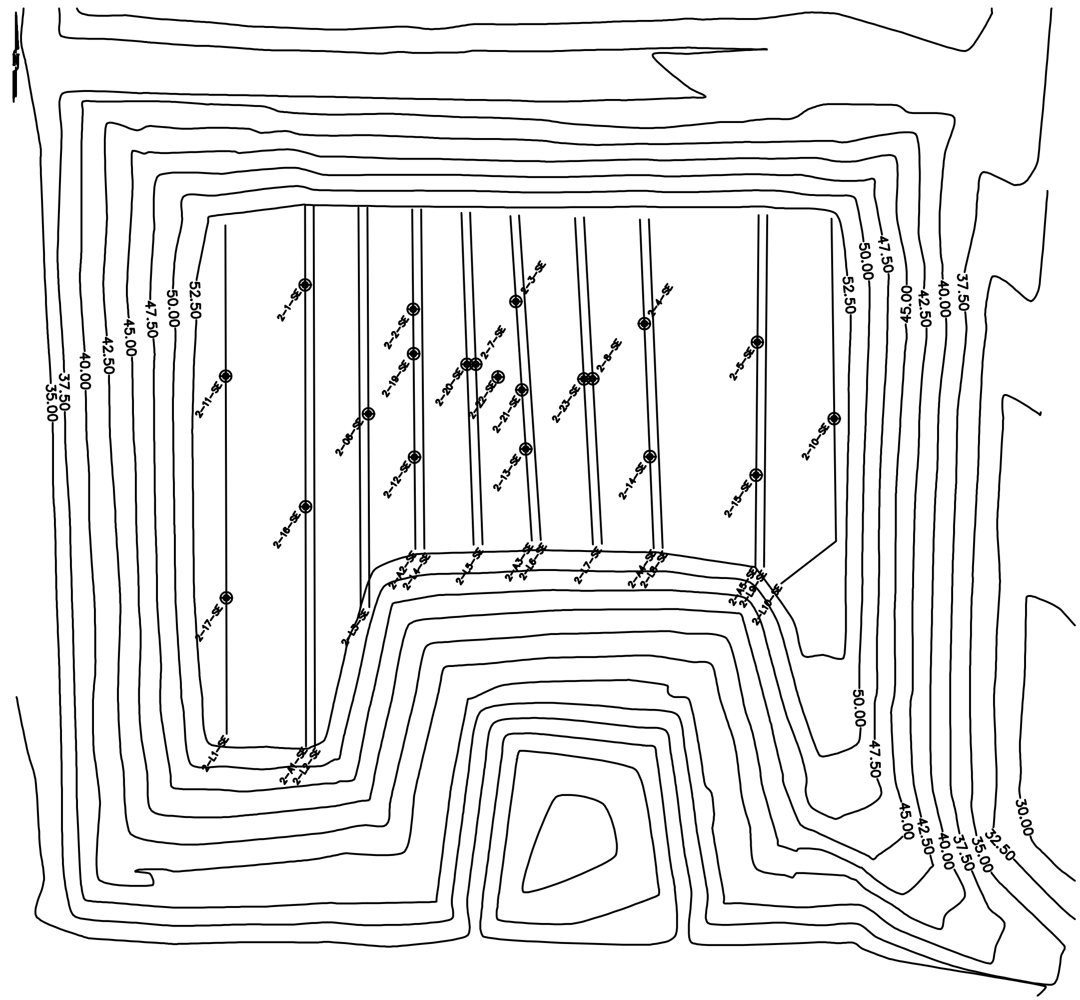
YOLO COUNTY CENTRAL LANDFILL
FULL-SCALE BIOREACTOR

SE AEROBIC MODULE LEVEL 1 PIPING AND INSTRUMENTATION

DRAWING NO. ______

W.O. NO.	9207
F.B. NO.	T.9N.R.3E.
DESIGN BY	JDK
DRAWN BY	JDK
CHECKED BY	RY
FILE NAME	——
DATE	8/6/02

DETAIL
5-3



SENSOR DESIGNATION	NORTHING	EASTING	ELEVATION (MSL)
2-1-SE	1979604	6651380	51
2-2-SE	1979596	6651417	51
2-3-SE	1979599	6651452	52
2-4-SE	1979591	6651495	52.5
2-5-SE	1979585	6651533	52
2-6-SE	1979561	6651402	51
2-7-SE	1979572	6651438	51.5
2-8-SE	1979572	6651478	52
2-9-SE	NOT INSTALLED		
2-10-SE	1979559	6651559	52
2-11-SE	1979573	6651354	51
2-12-SE	1979546	6651418	51
2-13-SE	1979549	6651455	52
2-14-SE	1979546	6651497	52.5
2-15-SE	1979540	6651533	52
2-16-SE	1979529	6651381	51
2-17-SE	1979498	6651354	51
2-18-SE	SENSOR LOST		
2-19-SE	1979581	6651417	51
2-20-SE	1979577	6651435	56
2-21-SE	1979569	6651454	57
2-22-SE	1979573	6651446	56
2-23-SE	1979572	6651475	57

LEGEND

HORIZONTAL LEACHATE INJECTION LINE,1.25" ø, SDR 11 HDPE WITH 3/32" ø DRILLED HOLES @ 10' O/C

HORIZONTAL LEACHATE INJECTION LINE,1.25" ø, sCHEDULE 80 CPVC WITH 3/32" ø DRILLED HOLES @ 10' O/C

HORIZONTAL AIR COLLECTION LINE, ALTERNATING 4 AND 6-INCH CPVC

HORIZONTAL AIR COLLECTION LINE, ALTERNATING 6 AND 8-INCH COORIGATED METAL PIPE WITH HDPE INJECTION LINE INSIDE.

● THERMISTER, QUALITY THERMISTER NTC PROBE, 10,000 OHM RESISTANCE AT 25°C, TOLERANCE ±0.2°C (0–100°C), PRESSURE SENSING TUBE, 1/4-INCH ID BY 3/8 OD LLDPE, AND PVC MOISTURE SENSOR.

2-1-SE LEVEL 2, INSTRUMENT LOCATION 1, SOUTHEAST ANAEROBIC MODULE

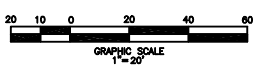
2-L1-SE LEVEL 2, LEACHATE INJECTION LINE 1, SOUTHEAST ANAEROBIC MODULE

2-A1-SE LEVEL 2, AIR COLLECTION LINE 1, SOUTHEAST MODULE

NOTES

1. ALL PIPING AND INSTRUMENTATION INSTALLED IN 3-FOOT WIDE BY 2-FOOT DEEP TRENCH. ALL TRENCHES WERE BACKFILLED WITH TIRES.
2. SENSORS DESIGNATED 0.5 WERE INSTALLED APPROXIMATELY 4-FEET ABOVE THE AEROBIC LINER.

AS-BUILT



WARNING: THE ORIGINAL DOCUMENTS CONTAIN A RED COLORED PROFESSIONAL SEAL AND BLACK SIGNATURE.

NO.	REVISIONS DESCRIPTIONS	DATE	APPV

YOLO COUNTY
DEPARTMENT OF PLANNING & PUBLIC WORKS
DIVISION OF INTEGRATED WASTE MANAGEMENT
292 WEST BEAMER ST., WOODLAND, CA 95695

ASSISTANT DIRECTOR OF PUBLIC WORKS

APPROVED ____________ 19 ______ R. E. NO. ______

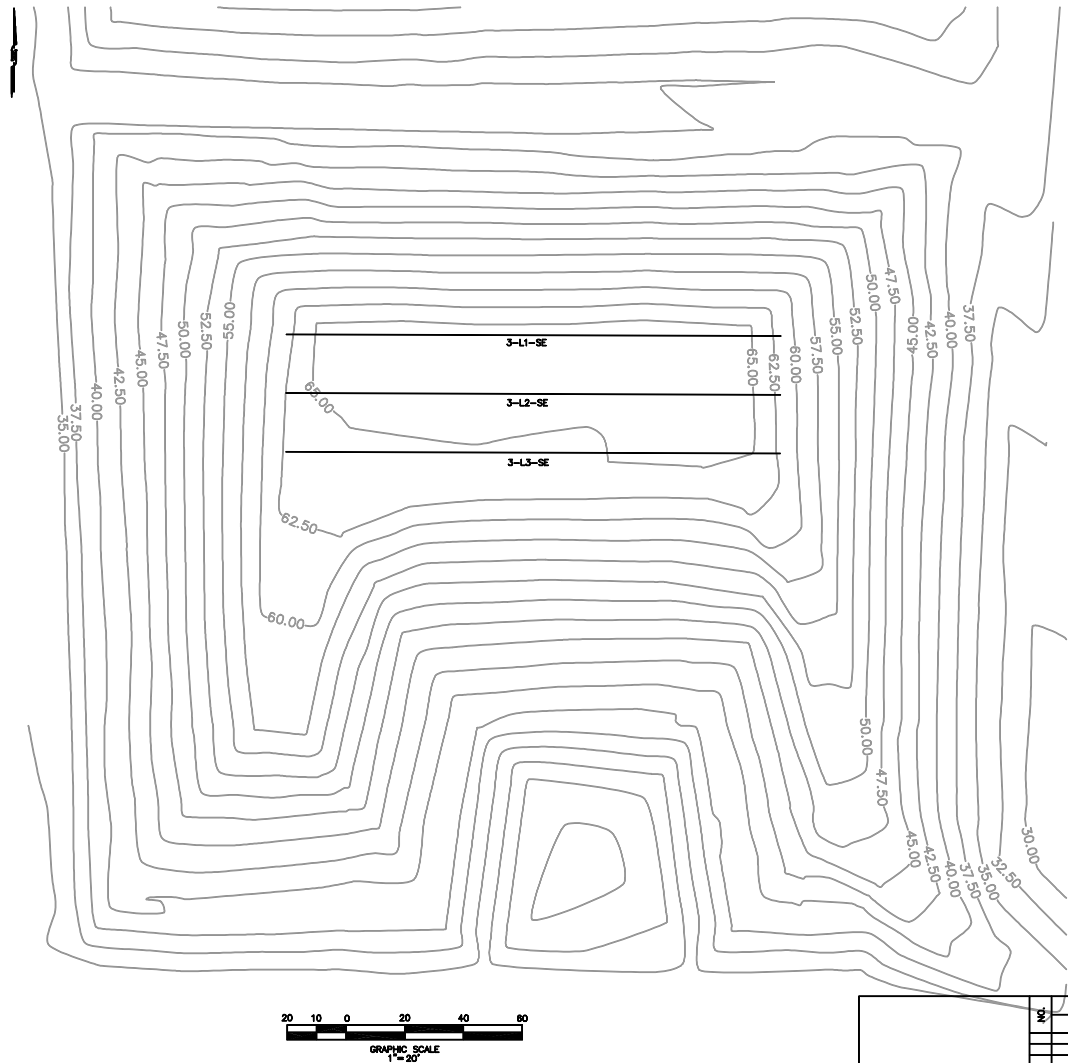
YOLO COUNTY CENTRAL LANDFILL
FULL-SCALE BIOREACTOR

SE AEROBIC MODULE LEVEL 2 PIPING AND INSTRUMENTATION

DRAWING NO. ______

W.O. NO.	9207
F.B. NO.	T.9N.R.3E.
DESIGN BY	JDK
DRAWN BY	JDK
CHECKED BY	RY
FILE NAME	———
DATE	8/6/02

DETAIL 5-4



LEGEND

(solid line)	HORIZONTAL LEACHATE INJECTION LINE,1.25" ø, SDR 11 HDPE WITH 3/32" ø DRILLED HOLES @ 10' O/C
3-L1-SE	LEVEL 3, LEACHATE INJECTION LINE 1, SOUTHEAST ANAEROBIC MODULE

NOTES

1. ALL PIPING AND INSTRUMENTATION INSTALLED IN 3-FOOT WIDE BY 2-FOOT DEEP TRENCH. ALL TRENCHES WERE BACKFILLED WITH TIRES.

AS-BUILT

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YOLO COUNTY CENTRAL LANDFILL
FULL-SCALE BIOREACTOR

SE AEROBIC MODULE LEVEL 3 PIPING AND INSTRUMENTATION

DRAWING NO. ________

W.O. NO.	9207
F.B. NO.	T.9N.R.3E.
DESIGN BY	JDK
DRAWN BY	JDK
CHECKED BY	RY
FILE NAME	----
DATE	8/6/02

DETAIL 5-5

MONITORING POINT COORDINATES			
SENSOR DESIGNATION	NORTHING	EASTING	ELEVATION (MSL)
0–01	1980033	6650992	29
0–02	1980033	6651067	28
0–03	1980033	6651142	28
0–04	1980033	6651217	29
0–05	1979958	6650992	29
0–06	1979958	6651067	27.5
0–07	1979958	6651142	27.5
0–08	1979958	6651217	29
0–09	1979883	6650992	28
0–10	1979883	6651067	27
0–11	1979883	6651142	27
0–12	1979883	6651217	28.5
0–13	1979808	6650992	28
0–14	1979808	6651067	26.5
0–15	1979808	6651142	26.5
0–16	1979808	6651217	28
0–17	1979733	6650992	27.5
0–18	1979733	6651067	26
0–19	1979733	6651142	26
0–20	1979733	6651217	27.5
0–21	1980030	6651362	29
0–22	1980030	6651437	27.5
0–23	1980030	6651512	27.5
0–24	1979955	6651362	28
0–25	1979955	6651437	27
0–26	1979955	6651512	27
0–27	1979955	6651587	28.5
0–28	1979880	6651362	28
0–29	1979880	6651437	26.5
0–30	1979880	6651512	26.5
0–31	1979880	6651587	28
0–32	1979805	6651362	27.5
0–33	1979805	6651437	26
0–34	1979805	6651512	26
0–35	1979805	6651587	27.5
0–36	1979730	6651362	27
0–37	1979730	6651437	25.5
0–38	1979730	6651512	25.5
0–39	1979730	6651587	27
0–40	1979604	6650917	28
0–41	1979604	6650922	26
0–42	1979604	6651067	25
0–43	1979604	6651142	25
0–44	1979604	6651217	26.5
0–45	1979529	6650917	27
0–46	1979529	6650922	26
0–47	1979529	6651067	24.5
0–48	1979529	6651142	24.5
0–49	1979529	6651217	26
0–50	1979454	6650917	27
0–51	1979454	6650922	25.5
0–52	1979454	6651067	24
0–53	1979454	6651142	24
0–54	1979454	6651217	25.5
0–55	1979604	6651362	26
0–56	1979604	6651437	24.5
0–57	1979604	6651512	24.5
0–58	1979604	6651587	26
0–59	1979529	6651362	25.5
0–60	1979529	6651437	24
0–61	1979529	6651512	24
0–62	1979529	6651587	25.5
0–63	1979454	6651362	25
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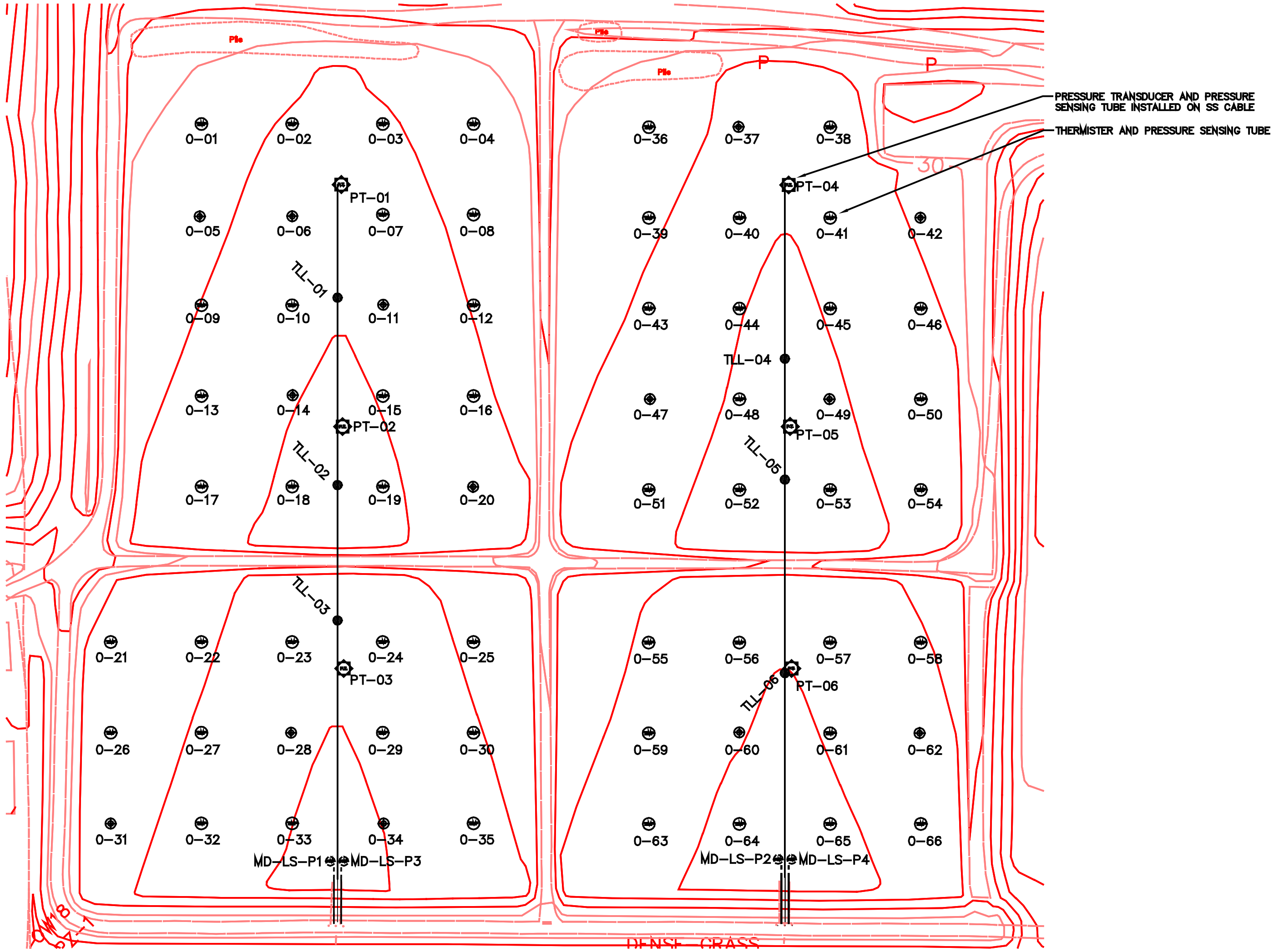
0–65	1979454	6651512	23.5
0–66	1979454	6651587	25



LEGEND

(pressure transducer symbol)	PRESSURE TRANSDUCER, DRUCK MODEL PTX 1830, 0–1 PSIG
(symbol)	THERMISTER, QUALITY THERMISTER NTC PROBE, 10,000 OHM RESISTANCE AT 25°C, TOLERANCE ±0.2°C (0–100°C). AND PRESSURE SENSING TUBE, 1/4–INCH ID BY 3/8 OD LLDPE.
●	THERMISTER, QUALITY THERMISTER NTC PROBE, 10,000 OHM RESISTANCE AT 25°C, TOLERANCE ±0.2°C (0–100°C), PRESSURE SENSING TUBE, 1/4–INCH ID BY 3/8 OD LLDPE, AND PVC MOISTURE SENSOR.
●	PRESSURE SENSING TUBE, 1/4–INCH ID BY 3/8 OD LLDPE.

INSTRUMENT DESIGNATION

0–02	THERMISTER, MOISTURE SENSOR, AND PRESSURE SENSING TUBE DESIGNATION. 0–02 DESIGNATES LEVEL 0, INSTRUMENT NUMBER 2
PT–01	PRESSURE TRANSDUCER AND PRESSURE SENSING TUBE. PT–01 DESIGNATES PRESSURE TRANSDUCER NUMBER 1
TLL–01	TRENCH LIQUID LEVEL, LOCATION 1

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DIVISION OF INTEGRATED WASTE MANAGEMENT
292 WEST BEAMER ST., WOODLAND, CA 95695

ASSISTANT DIRECTOR OF PUBLIC WORKS

APPROVED ______ 20____ R. E. NO. ______

YOLO COUNTY CENTRAL LANDFILL
FULL SCALE BIOREACTOR
BASE LINER
INSTRUMENTATION
PLAN

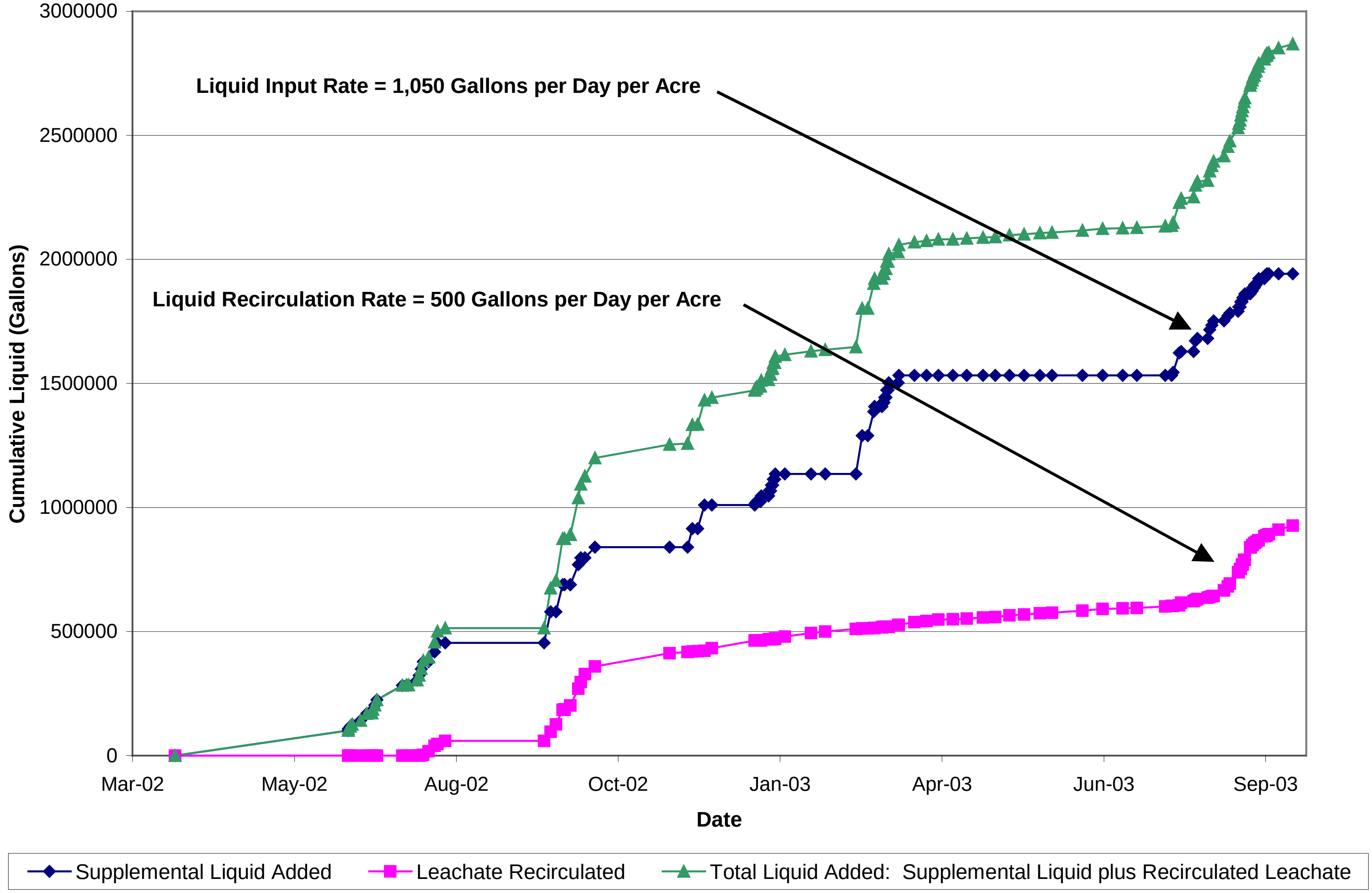
DRAWING NO. ______

W.O. NO.	9209
F.B. NO.	?
DESIGN BY	JDK
DRAWN BY	JDK
CHECKED BY	RY
FILE NAME	BASE_INST
DATE	8/14/00

DETAIL
6–3

APPENDIX C – GRAPHS

Figure 3-1. Northeast Anaerobic Cell Liquid Recirculation and Addition Volumes



Between September 24, 2002 and October 4, 2002 35,460 gallons of liquid was removed from the sump during injection line cleaning.

Figure 3-2. Northeast Anaerobic Cell Layer 1 Temperature Readings

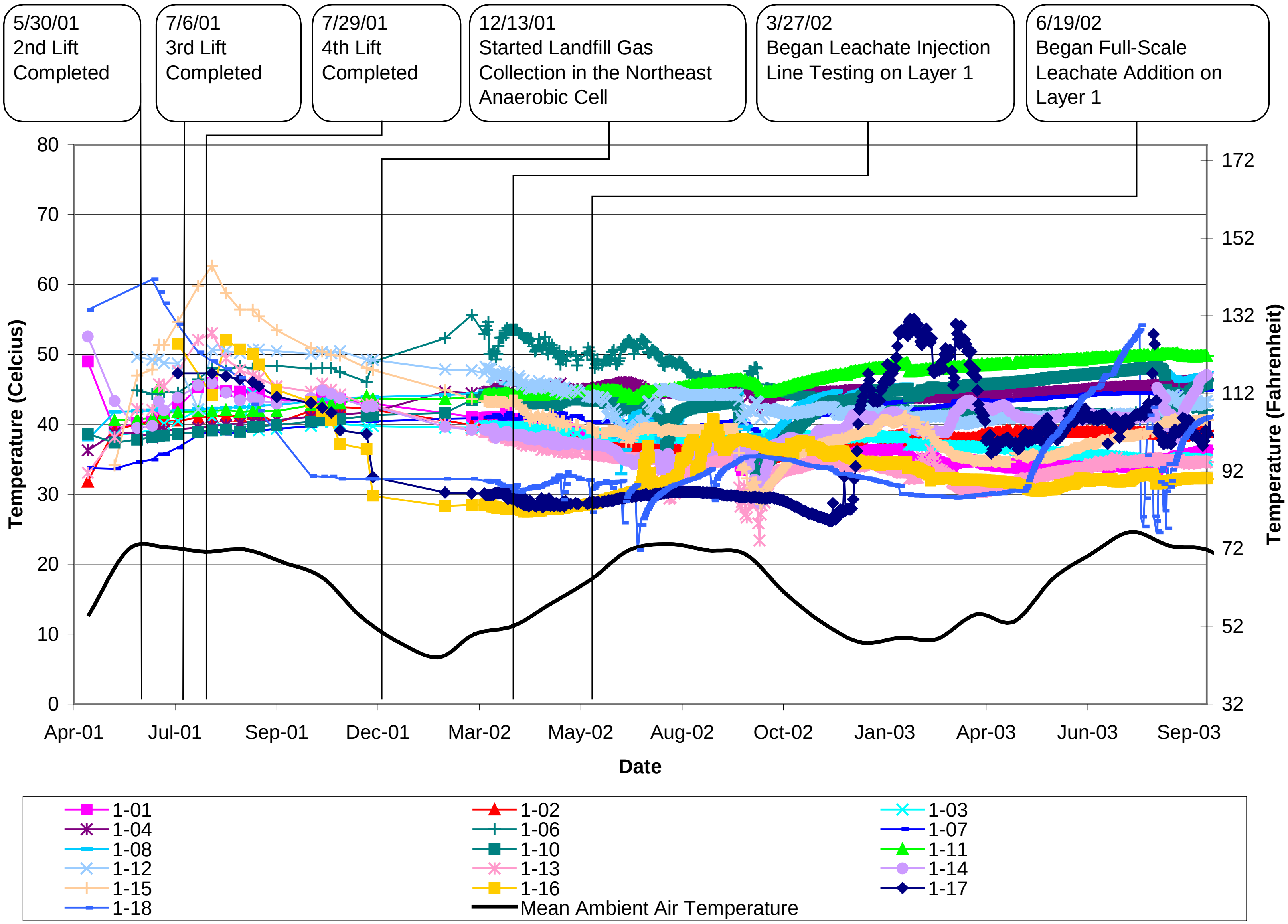


Figure 3-3. Northeast Anaerobic Cell Layer 2 Temperature Readings

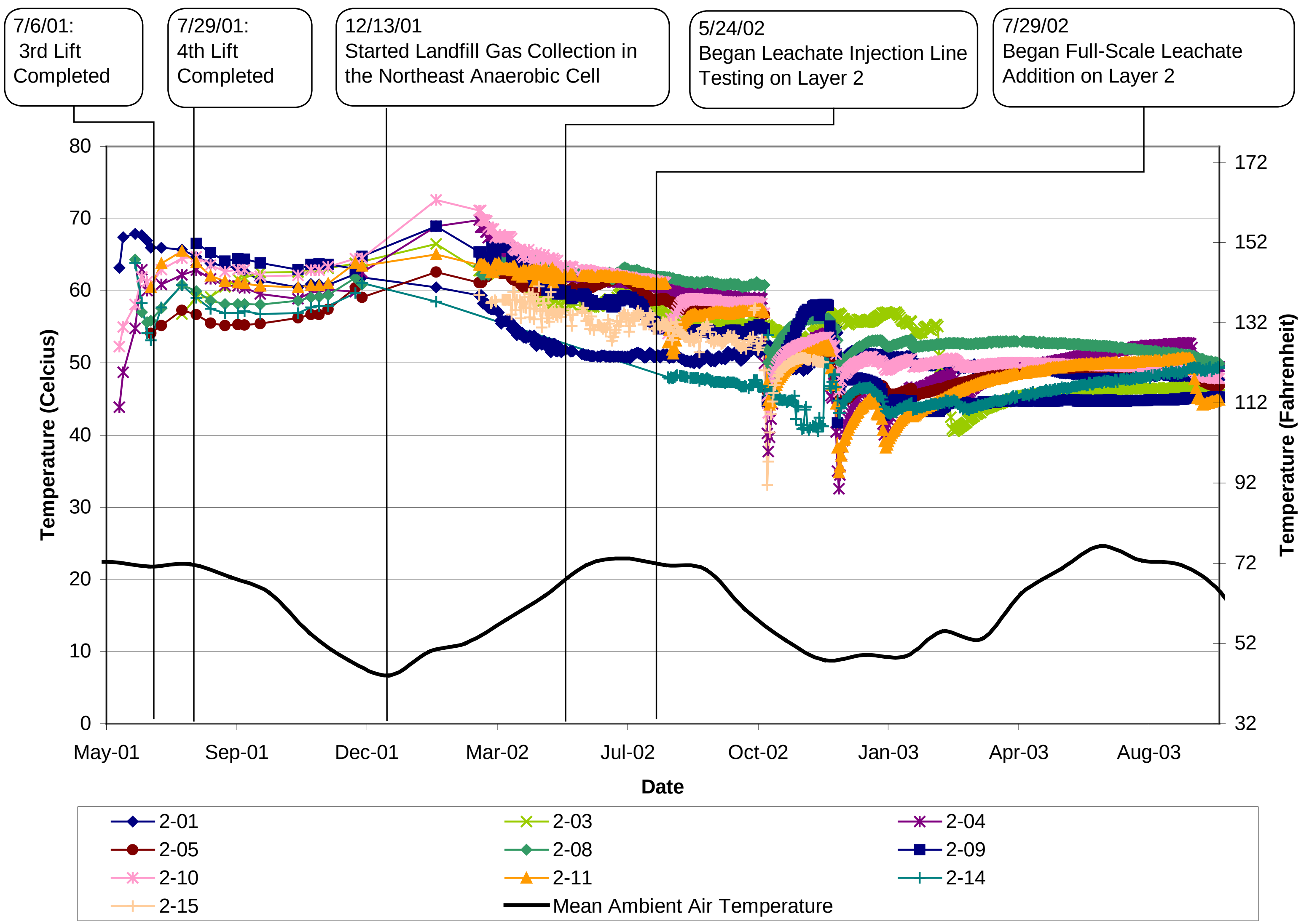


Figure 3-4. Northeast Anaerobic Cell Layer 3 Temperature Readings

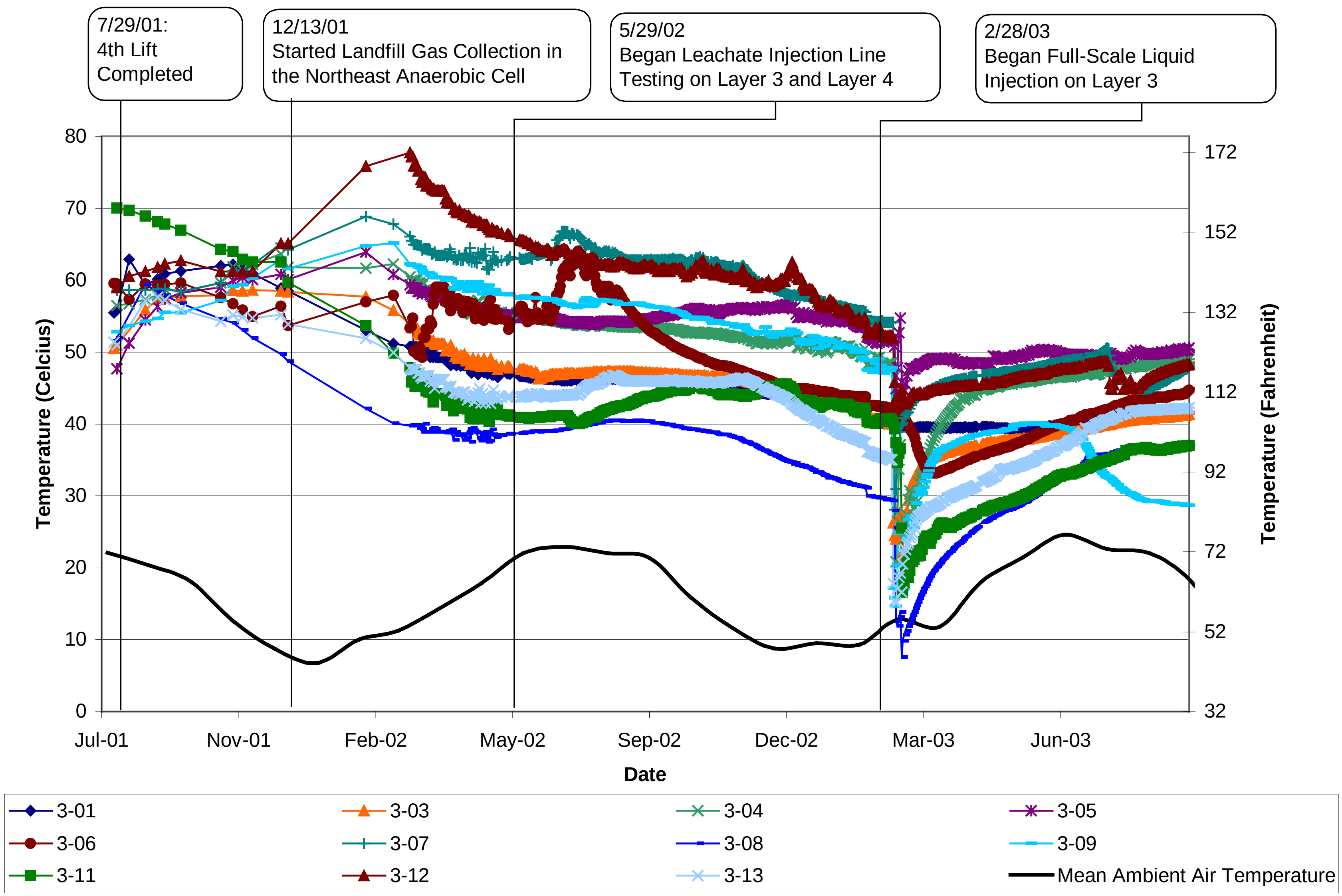


Figure 3-5. Northeast Anaerobic Cell Selected Temperature Readings

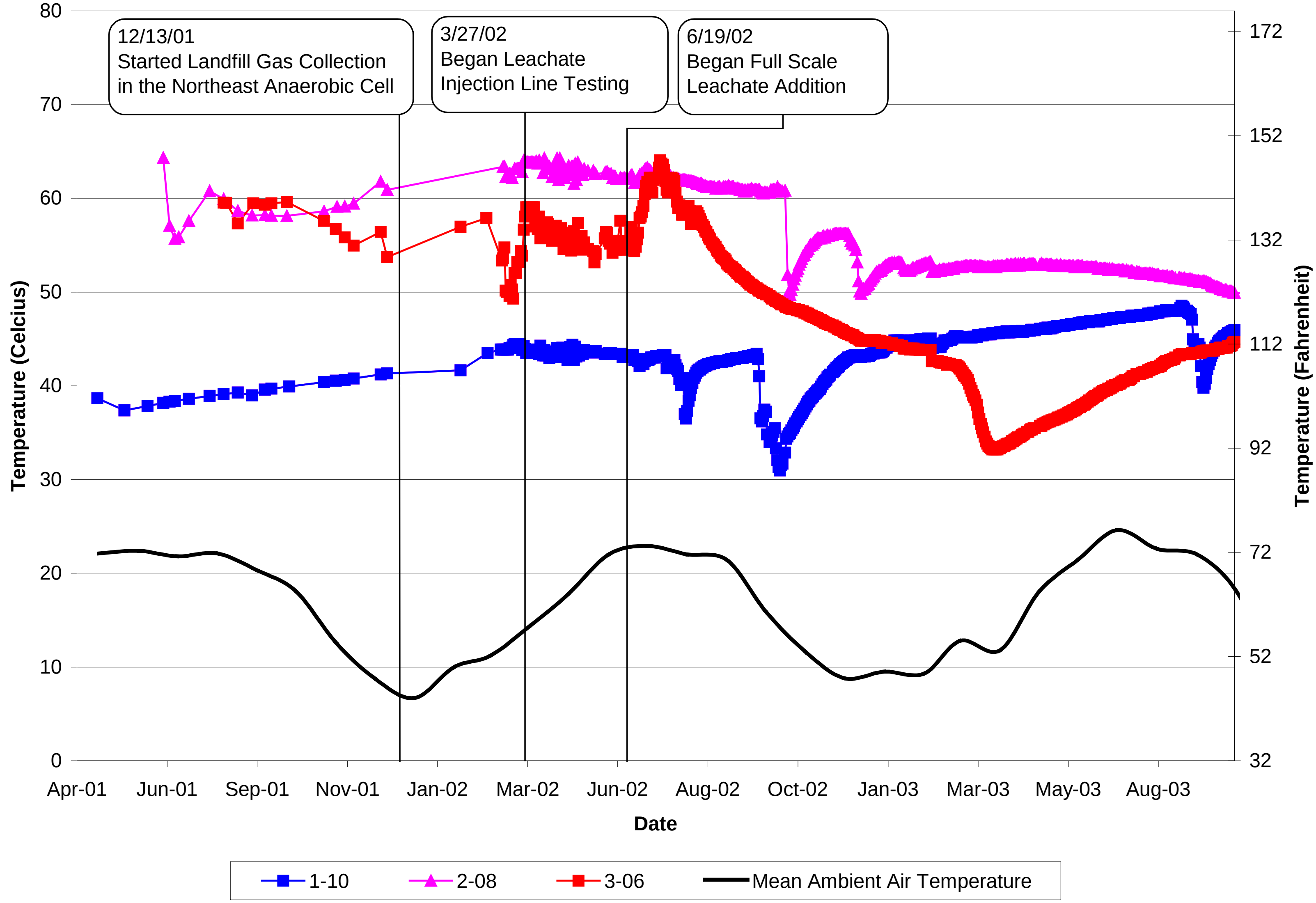


Figure 3-7. Northeast Anaerobic Cell Layer 1 PVC Moisture Readings

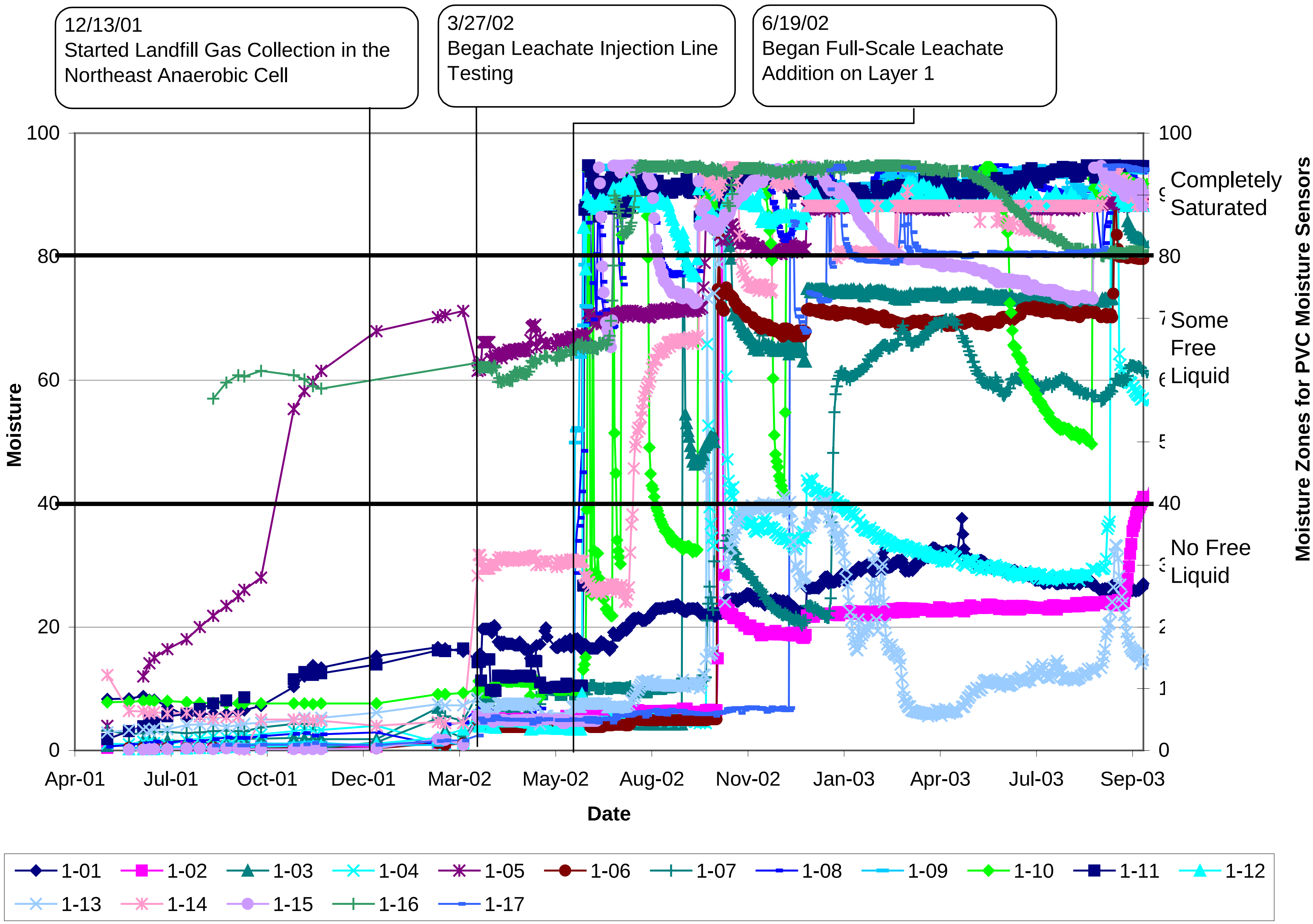


Figure 3-8. Northeast Anaerobic Cell Layer 2 PVC Moisture Readings

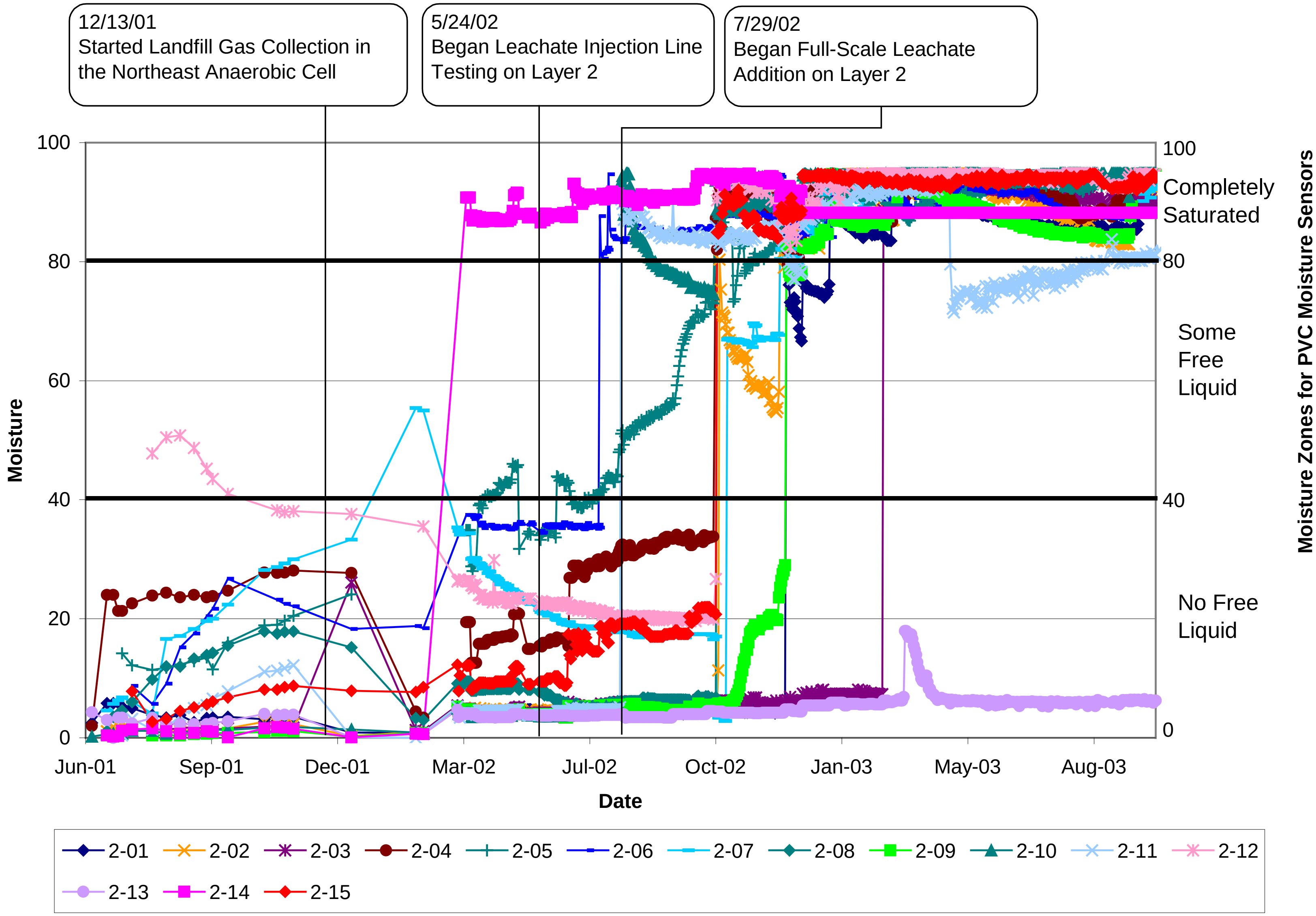


Figure 3-9. Northeast Anaerobic Cell Layer 2 Gypsum in Plaster Moisture Readings

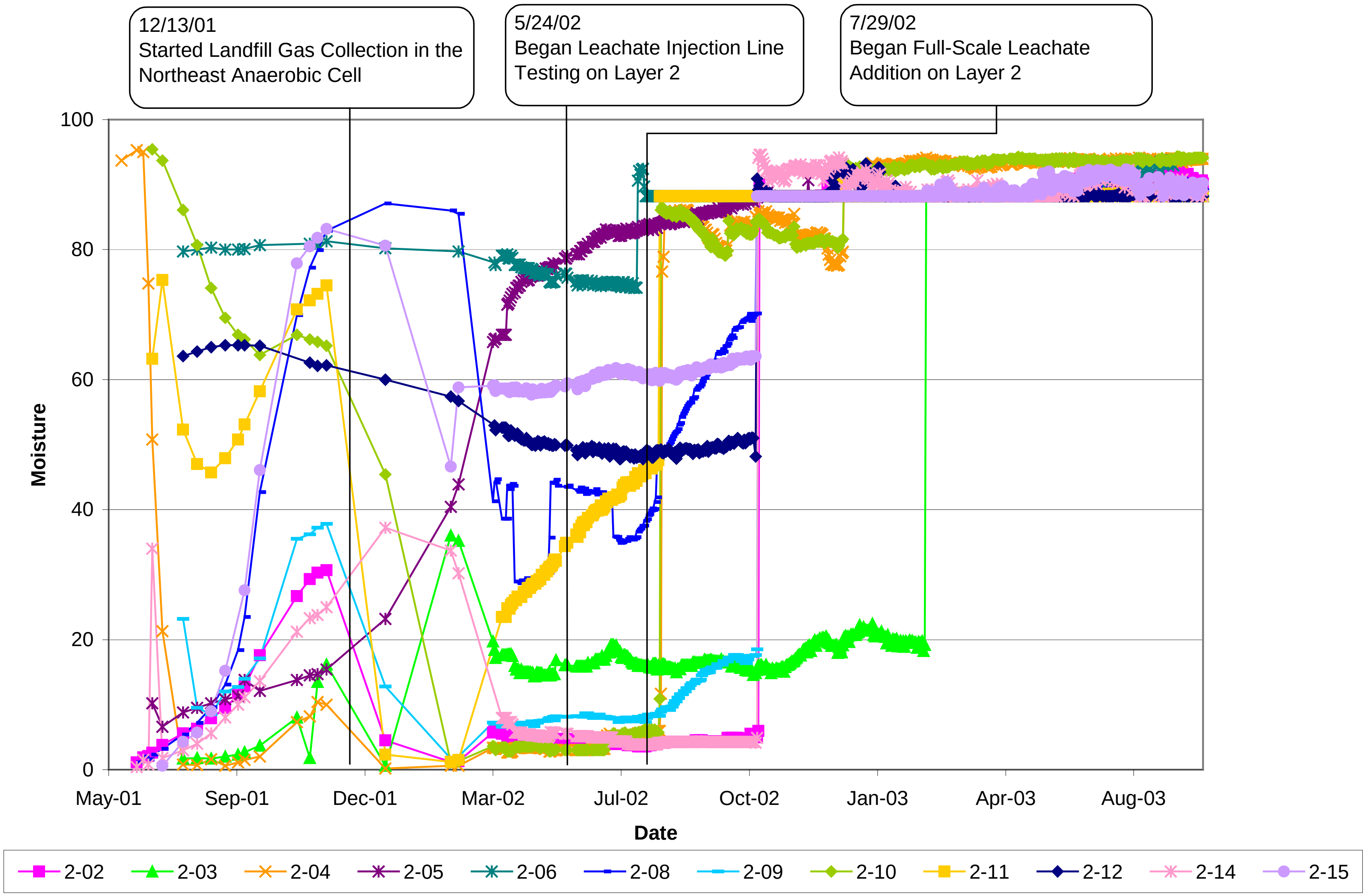


Figure 3-10. Northeast Anaerobic Cell Layer 2 Gypsum in Soil Moisture Readings

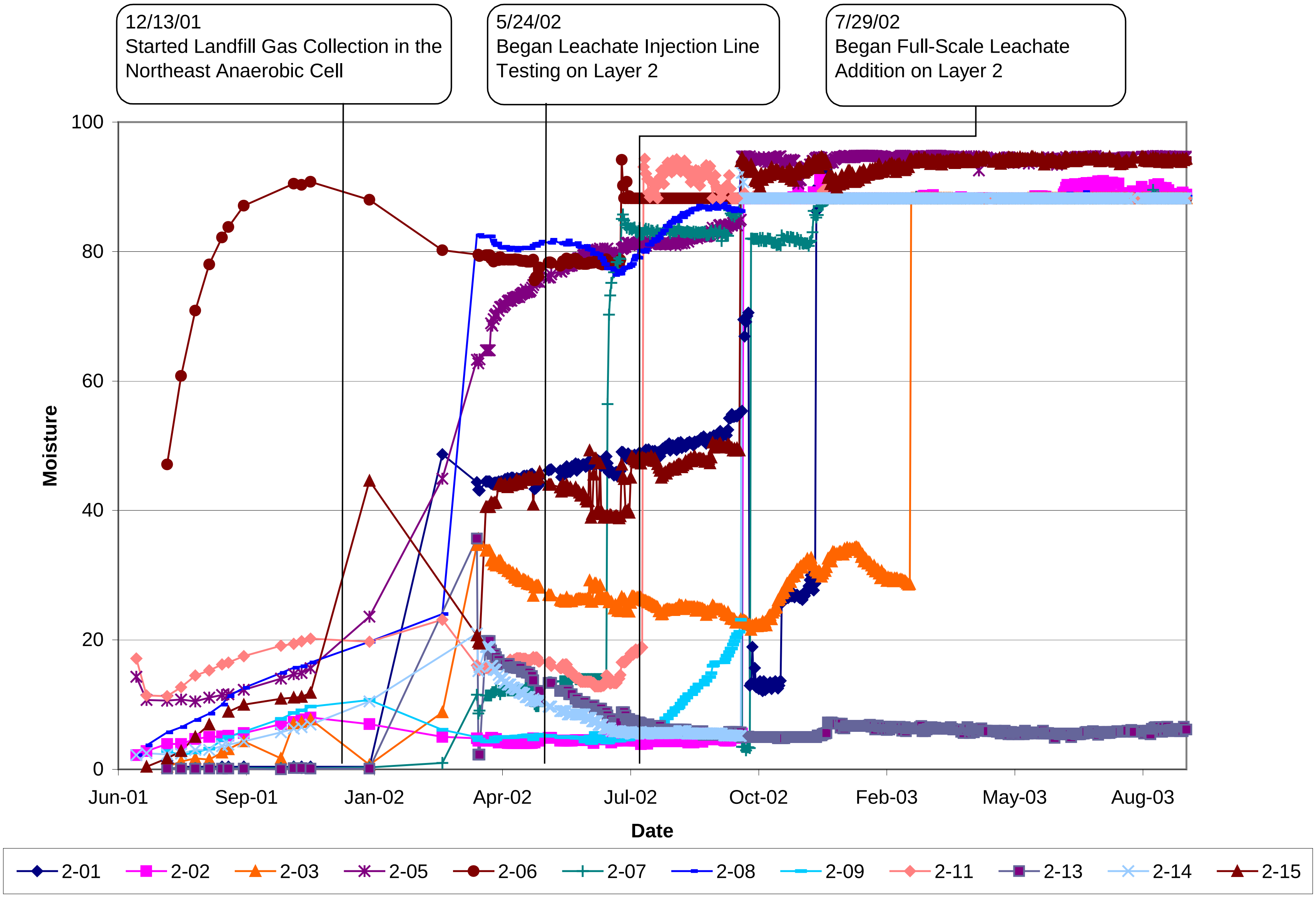


Figure 3-11. Northeast Anaerobic Cell Layer 3 PVC Moisture Readings

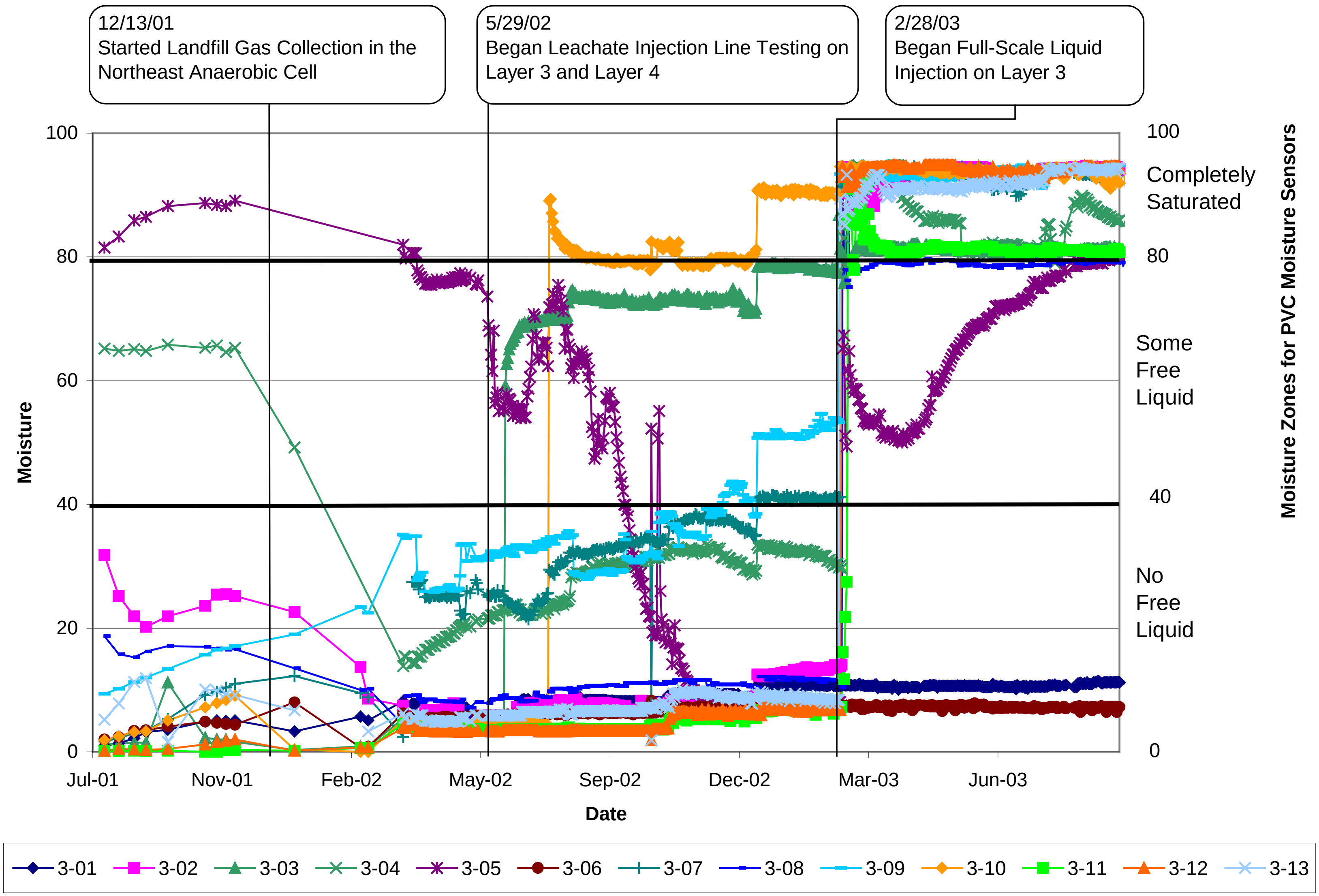


Figure 3-13. Northeast Anaerobic Cell Landfill Gas Concentrations from Header Line

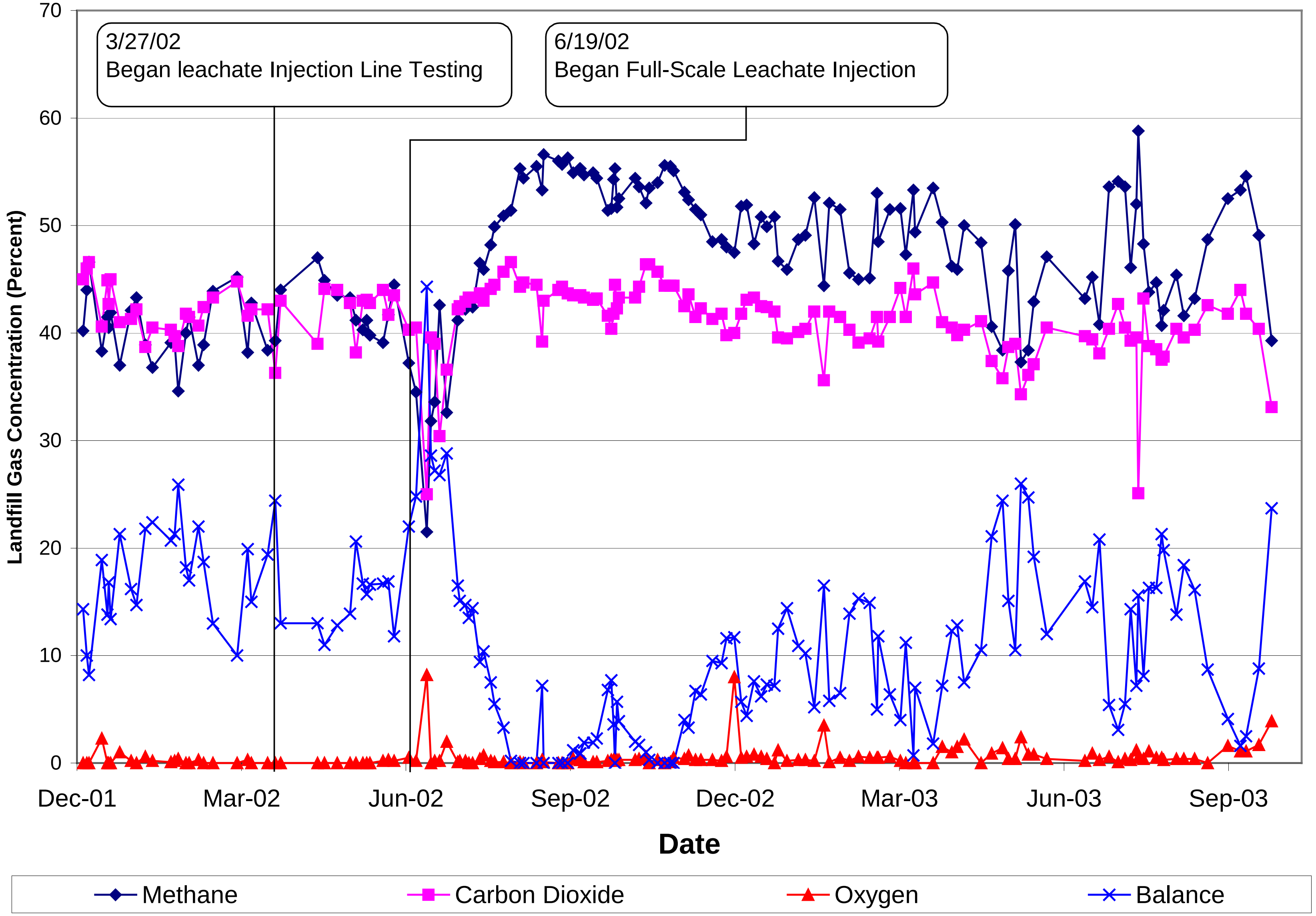
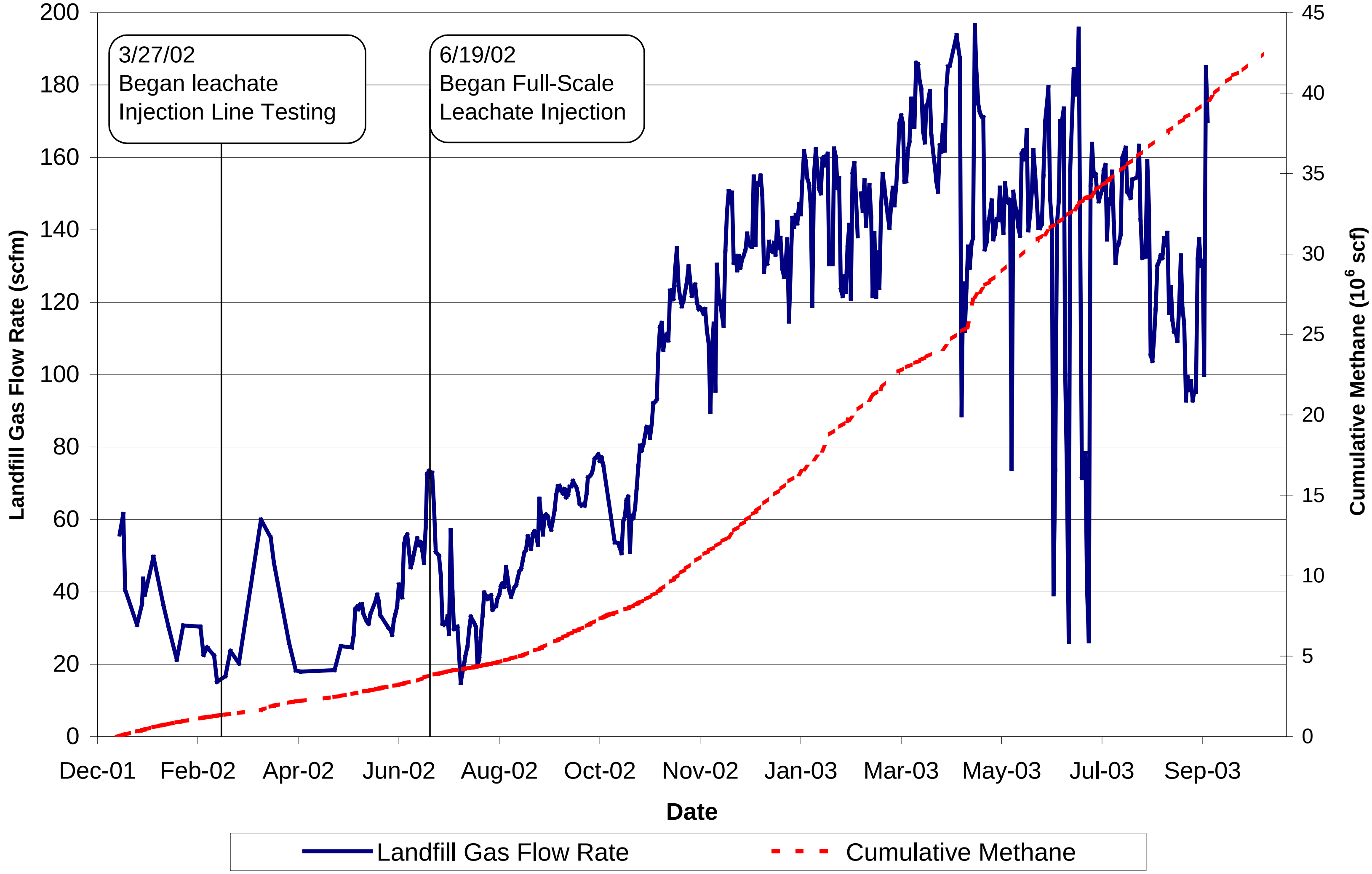


Figure 3-14. Northeast Anaerobic Cell LFG Flow Rate and Cumulative Methane



Note: Low flow rates were recorded on May 5, 2003, June 4, 2003, and June 29 and 30, 2003 as a result of the gas to energy facility temporarily shutting down.

Figure 3-15. Cumulative Methane from the Full Scale Project and the Pilot Scale Project

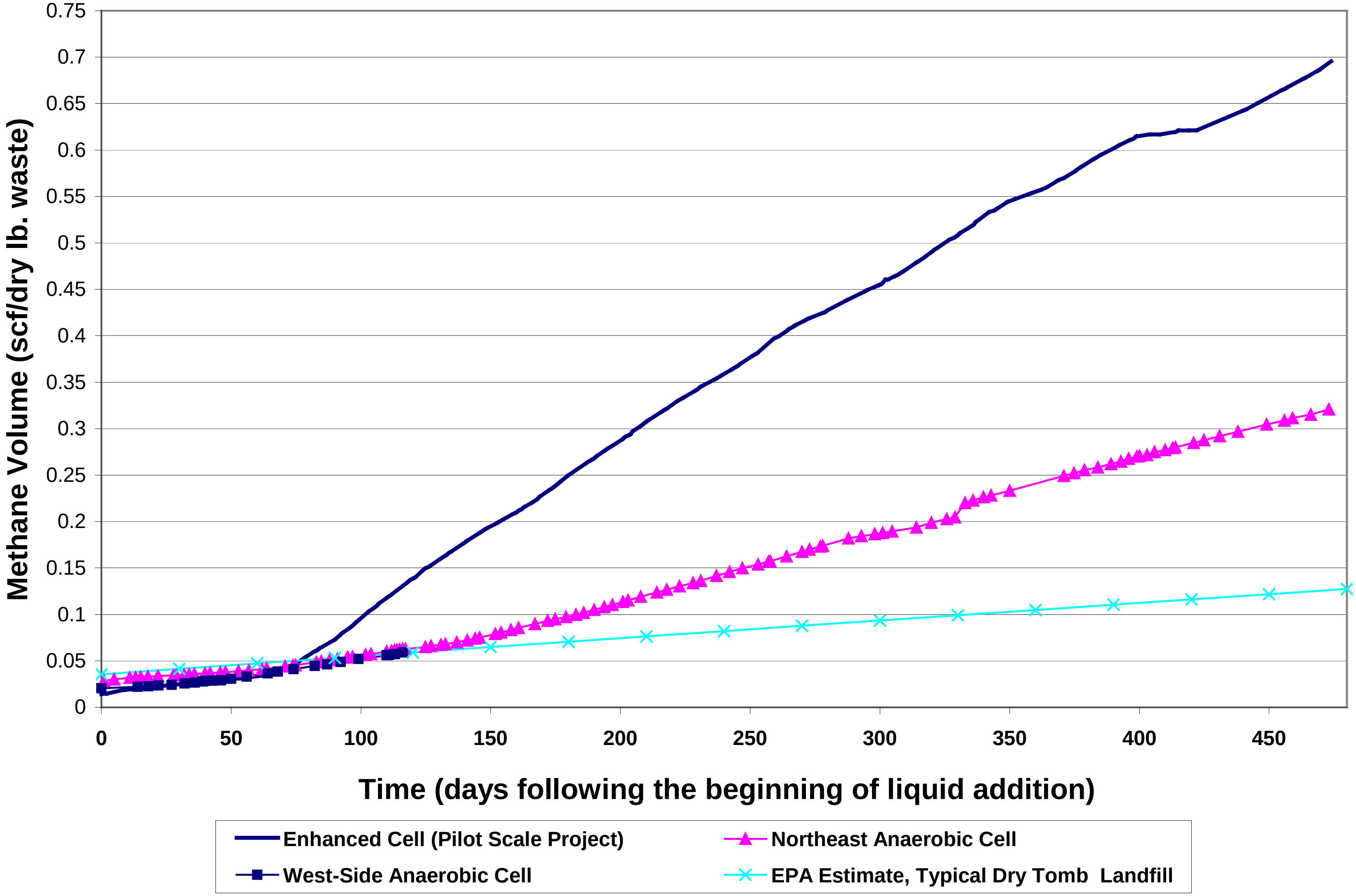


Figure 4-1. Cumulative Leachate Removed from the West-Side Leachate Collection and Removal System (LCRS)

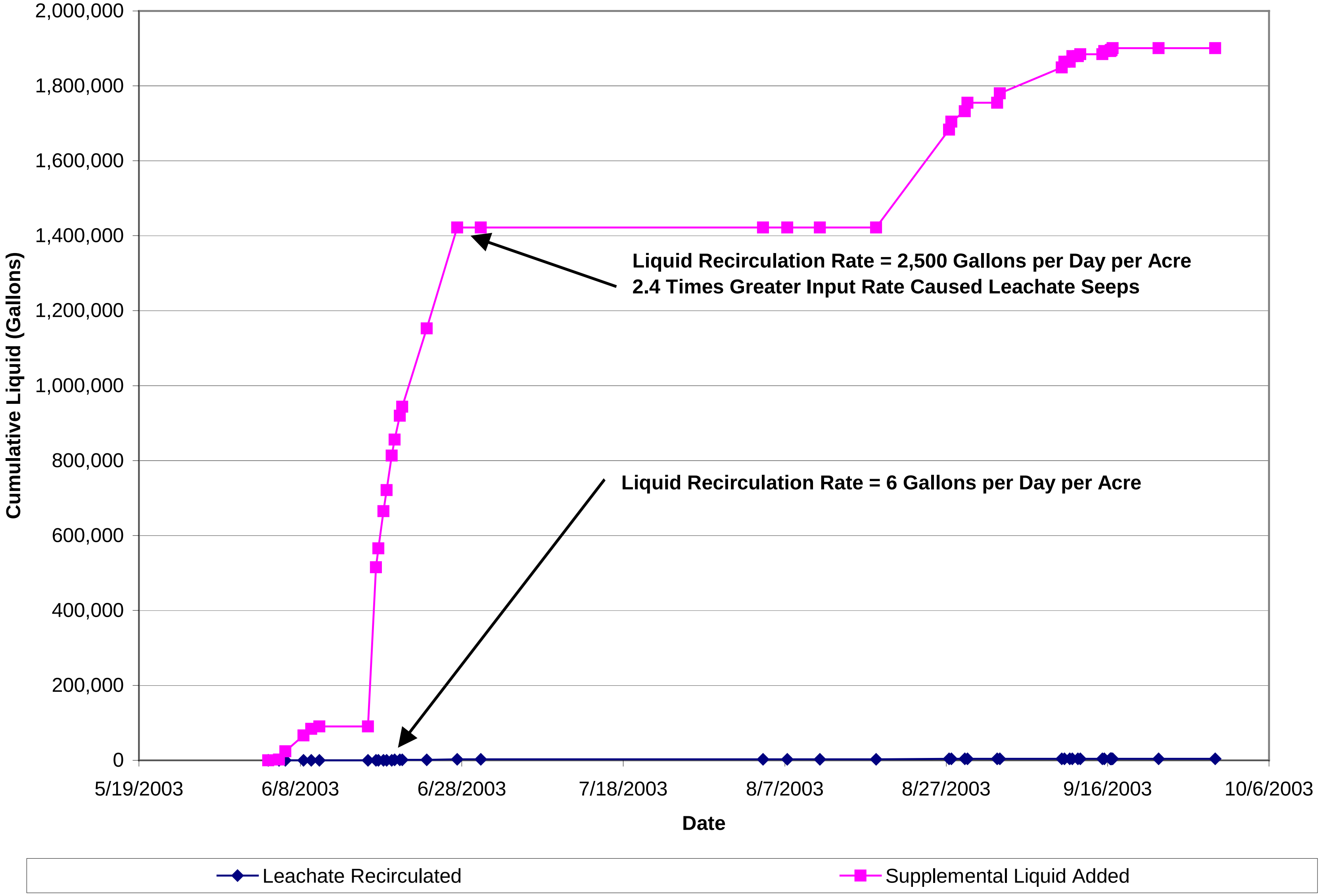


Figure 4-2. West-Side Anaerobic Cell Layer 1 Temperature Readings

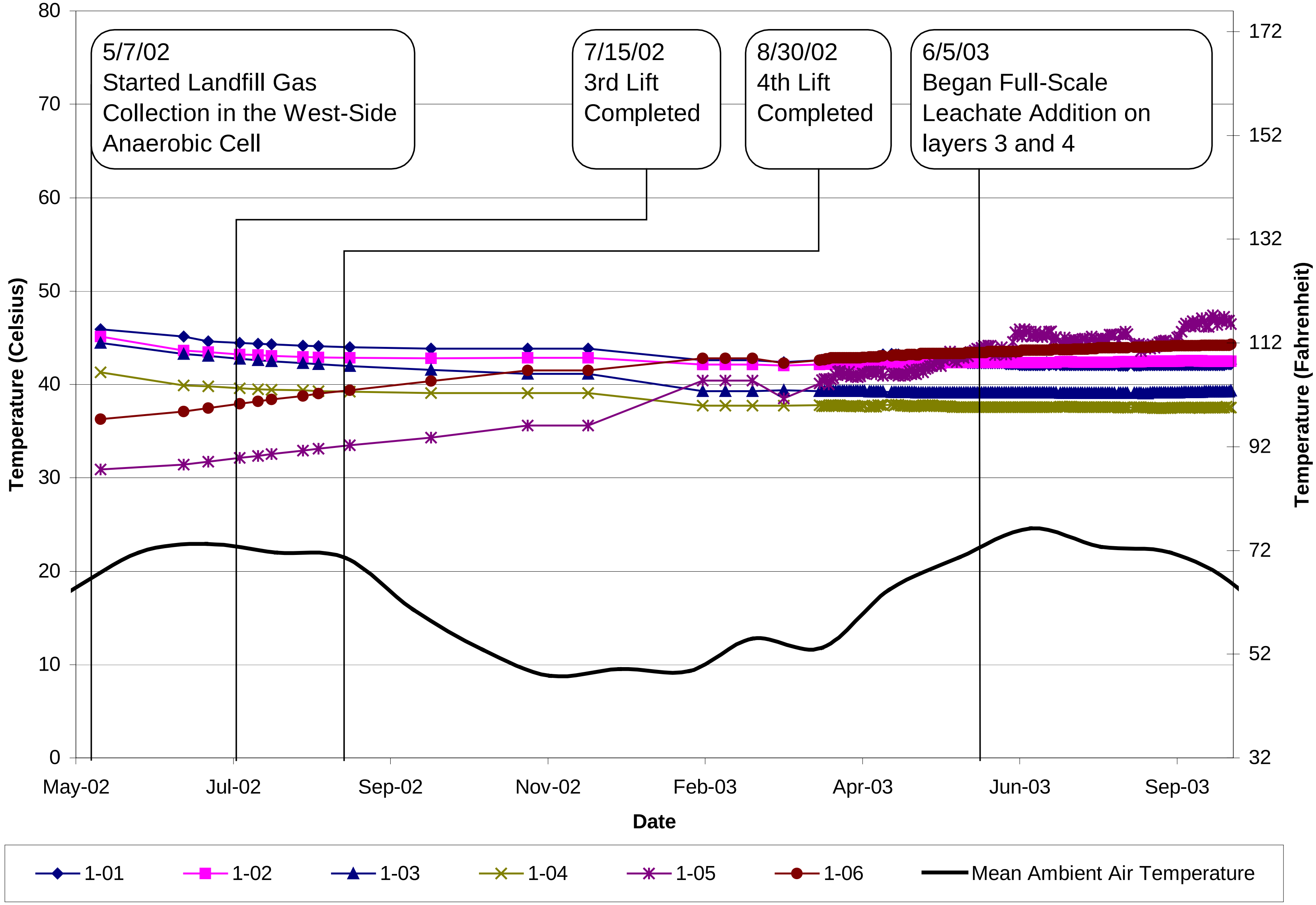


Figure 4-3. West-Side Anaerobic Cell Layer 2 Temperature Readings

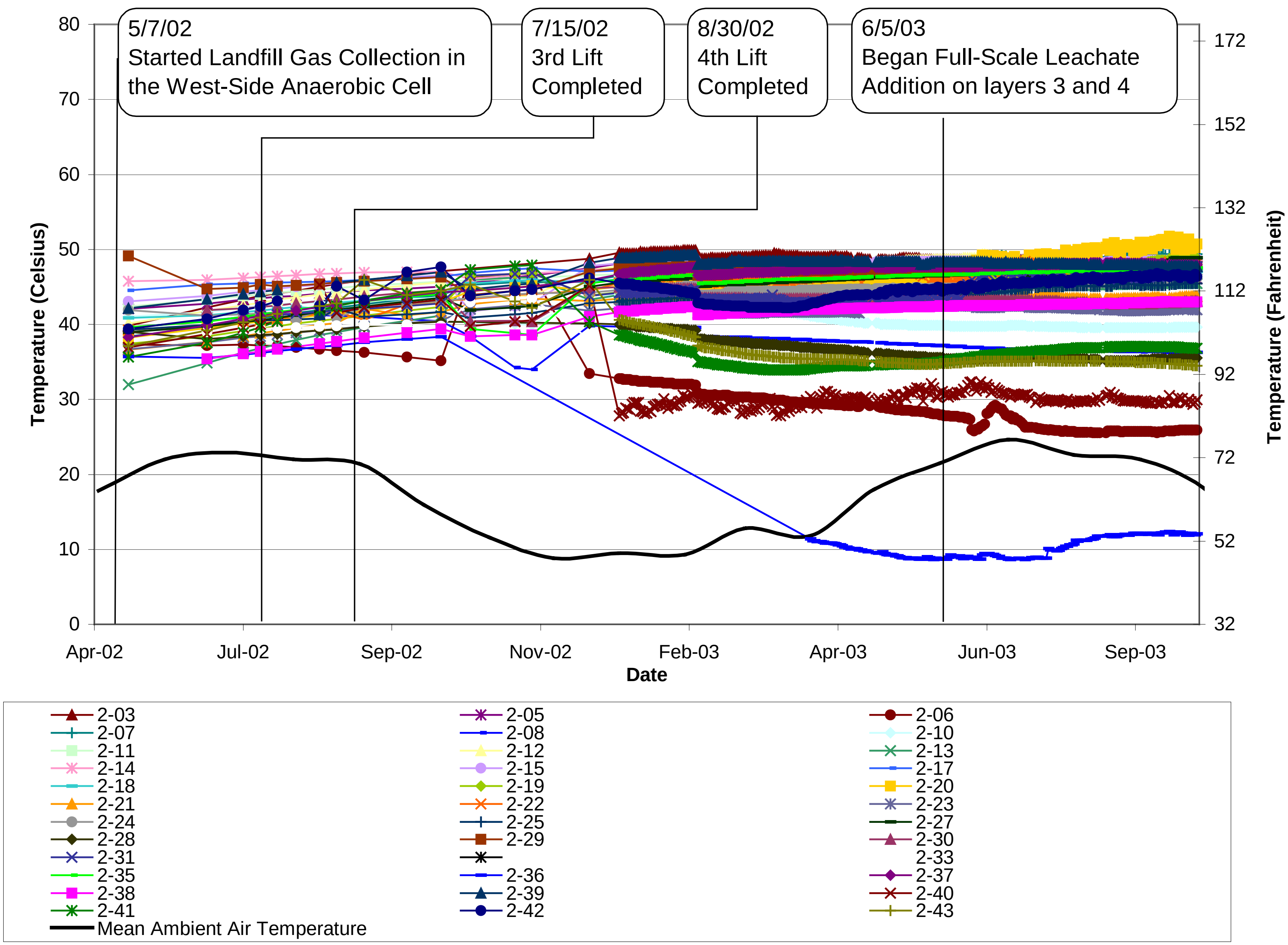


Figure 4-4. West-Side Anaerobic Cell Layer 3 Temperature Readings

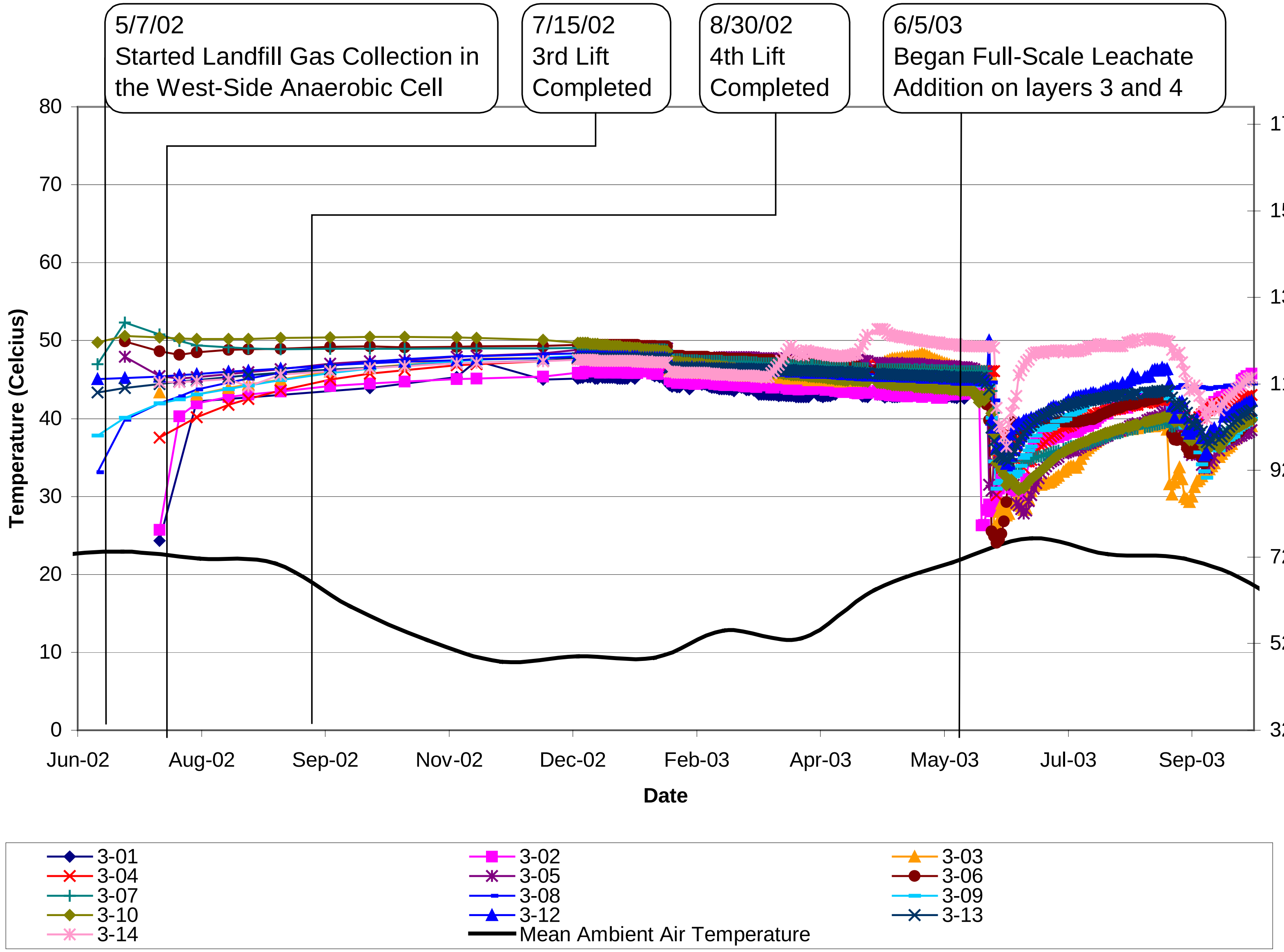


Figure 4-6. West-Side Anaerobic Cell Layer 1 PVC Moisture Readings

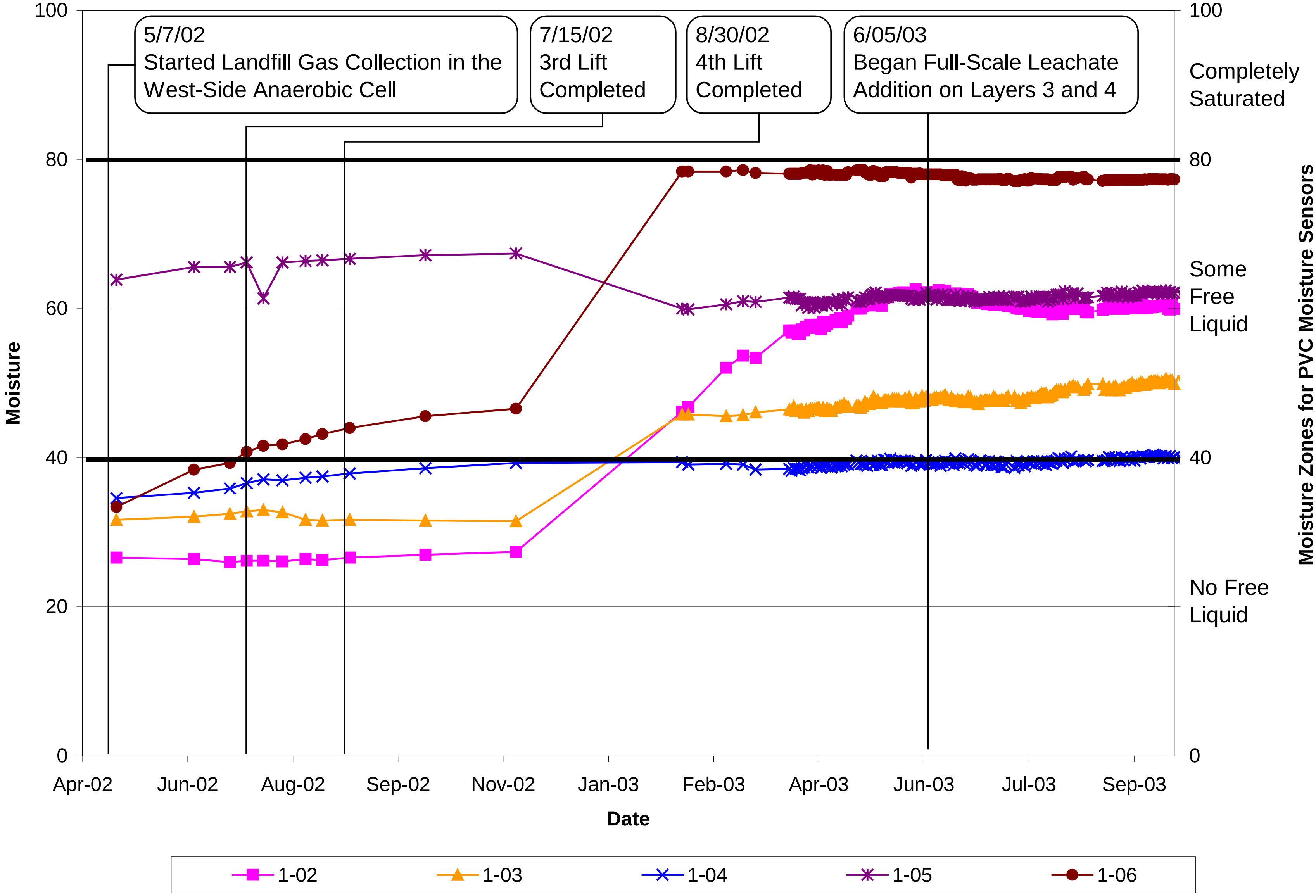


Figure 4-7. West-Side Anaerobic Cell Layer 2 PVC Readings

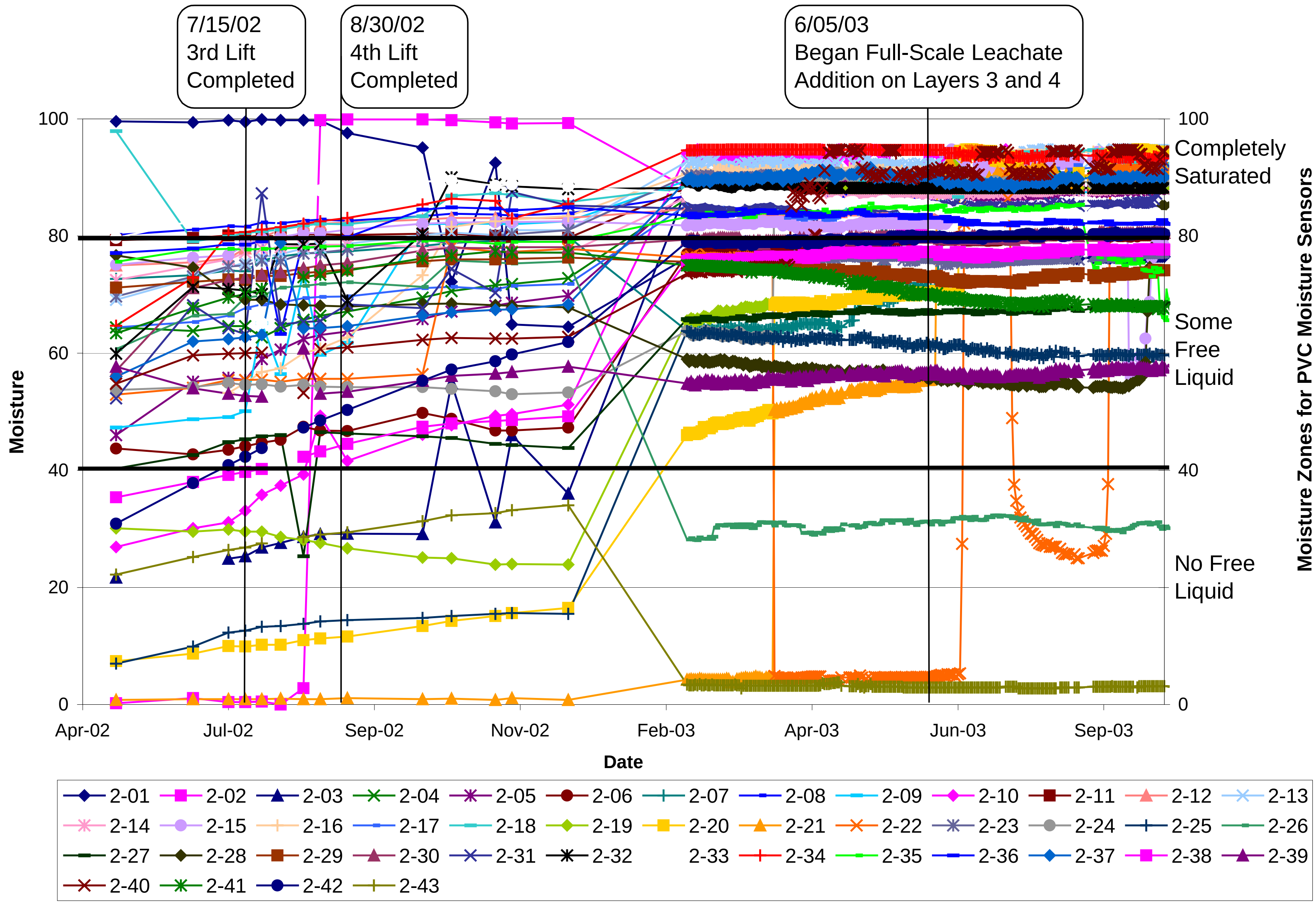


Figure 4-8. West-Side Anaerobic cell Layer 3 PVC Moisture Readings

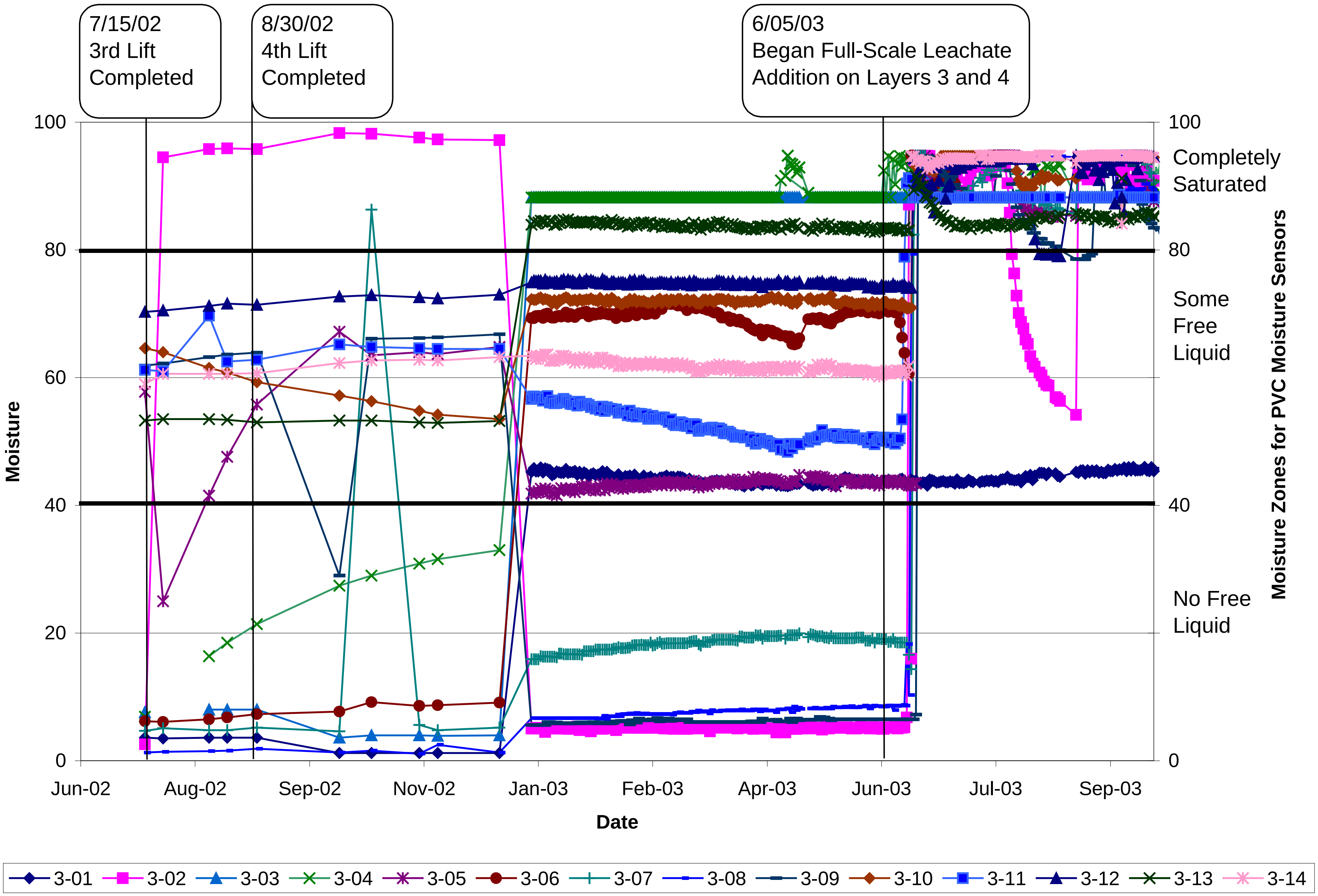


Figure 4-10. West-Side Anaerobic Cell Landfill Gas Concentrations from Header Line

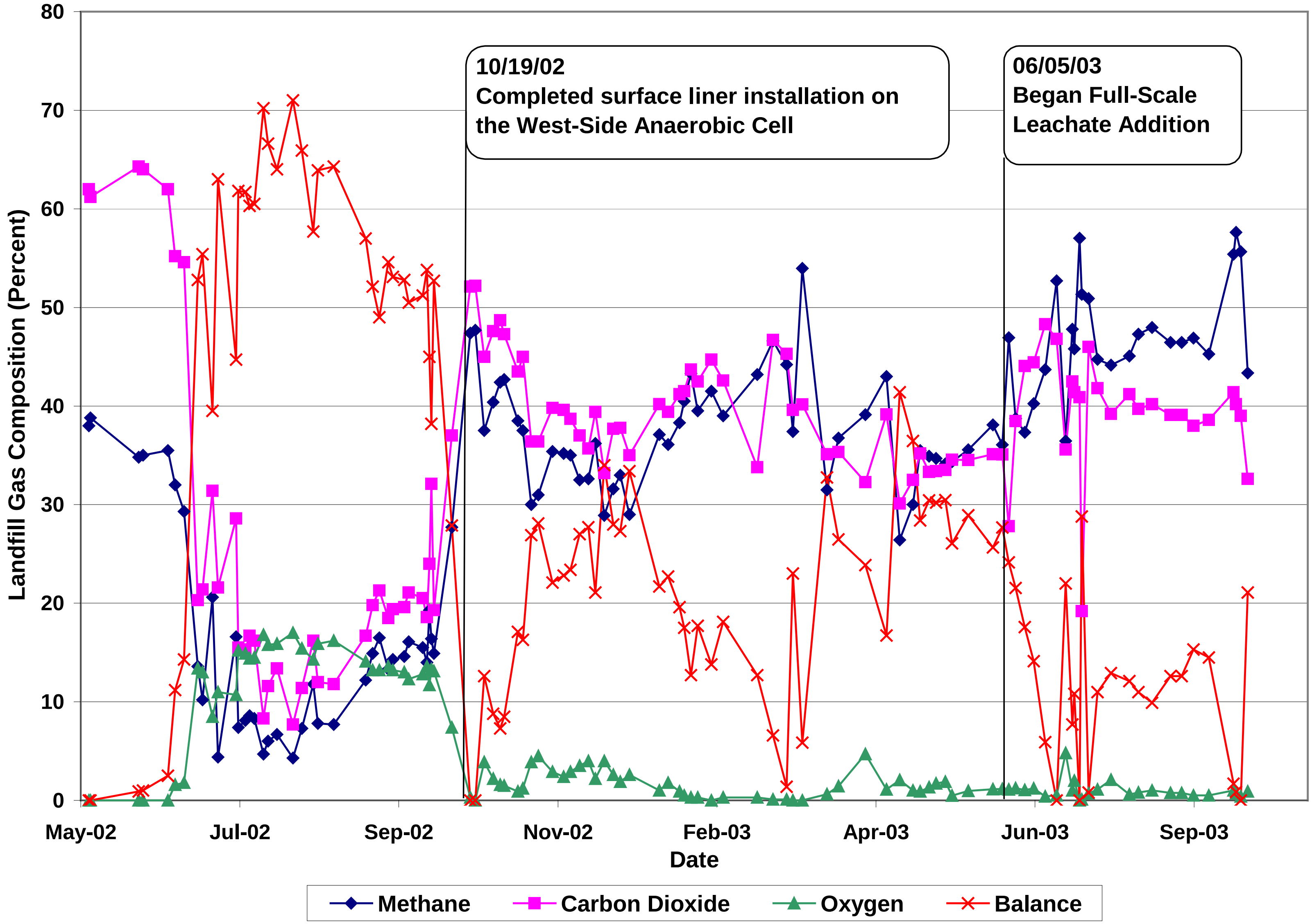


Figure 4-11. West-Side Anaerobic Cell LFG Flow Rate and Cumulative Methane

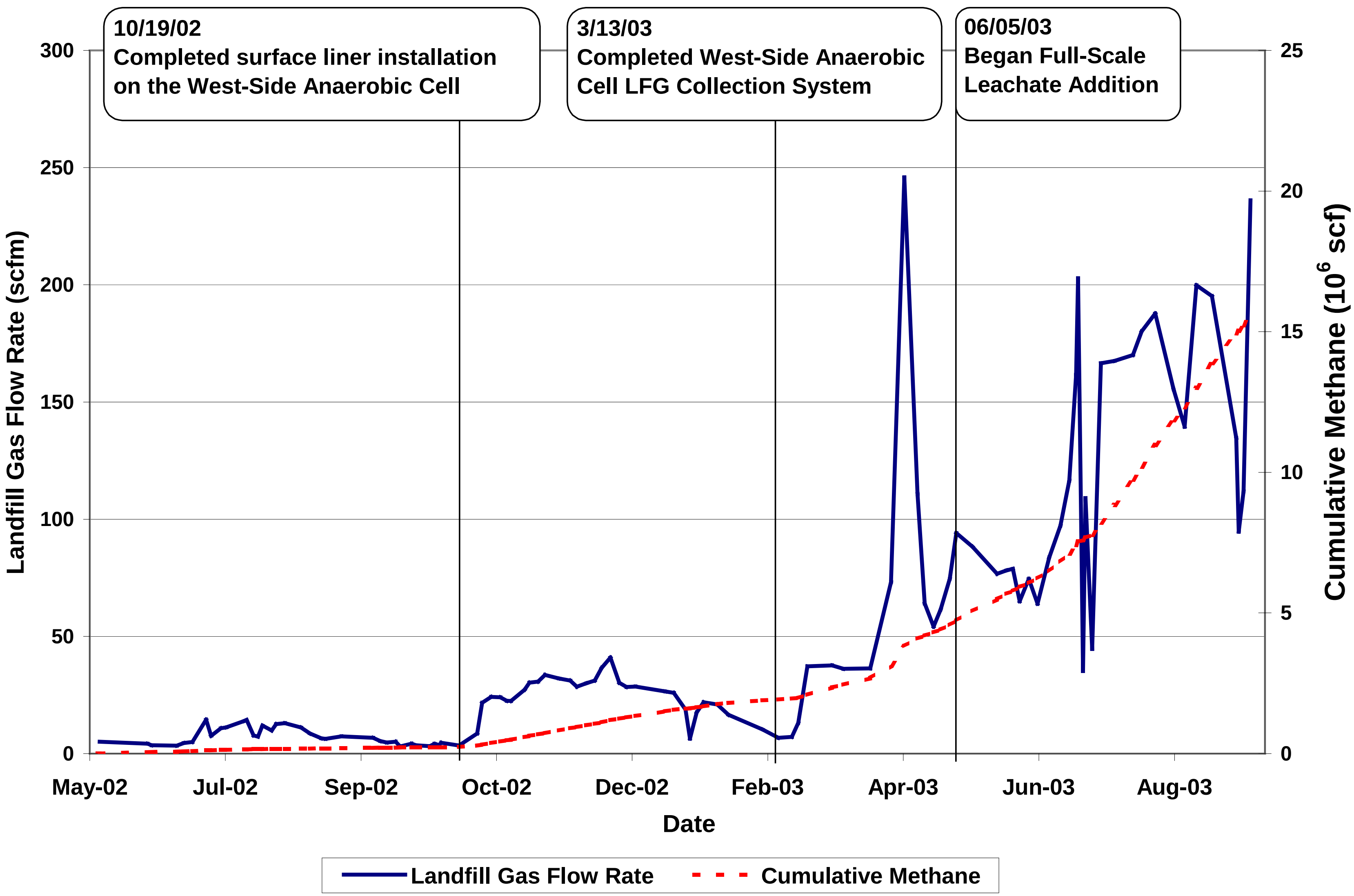


Figure 5-1. Aerobic Cell Base Liner Temperature Readings

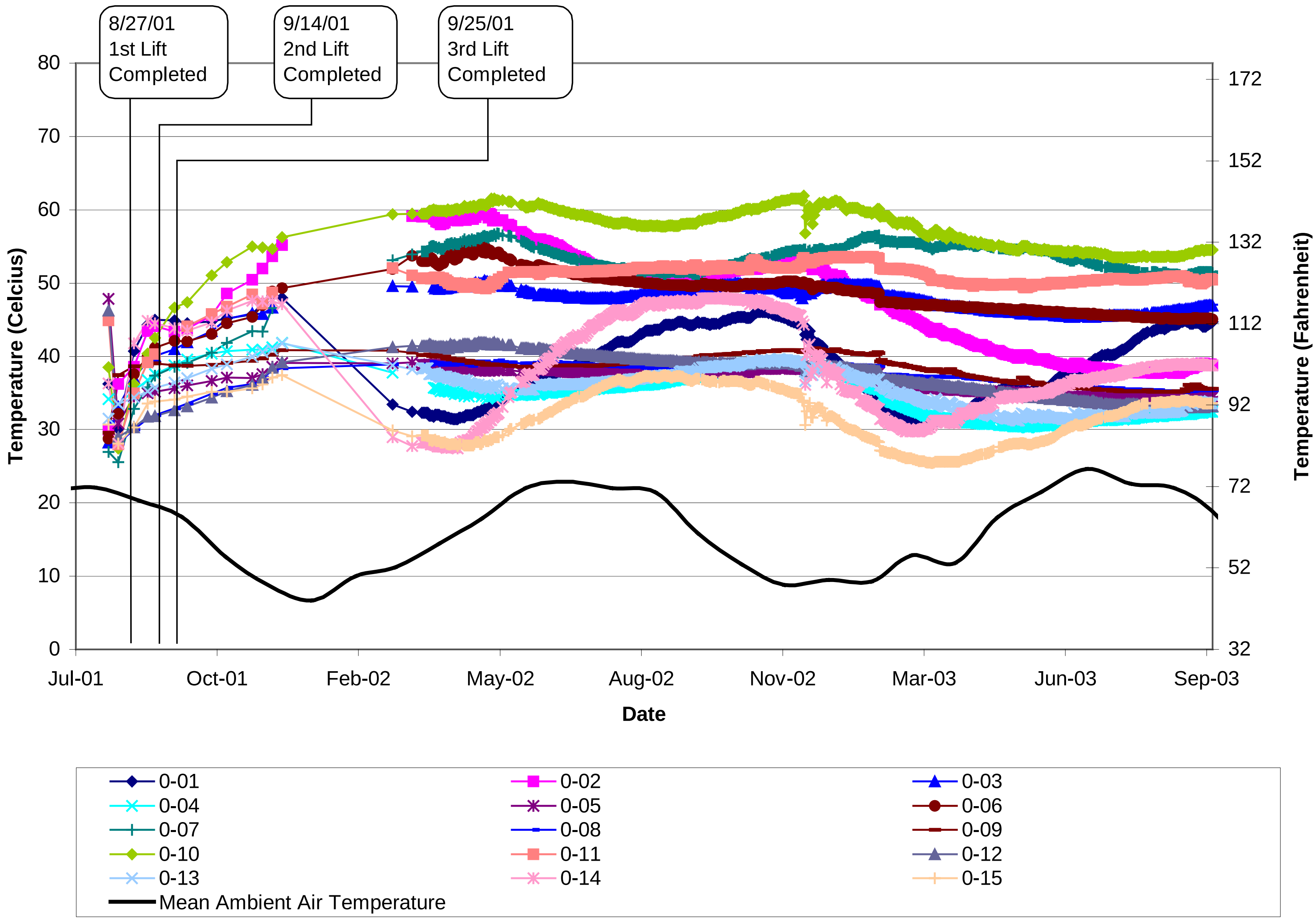


Figure 5-2. Aerobic Cell Layer 0.5 Temperature Readings

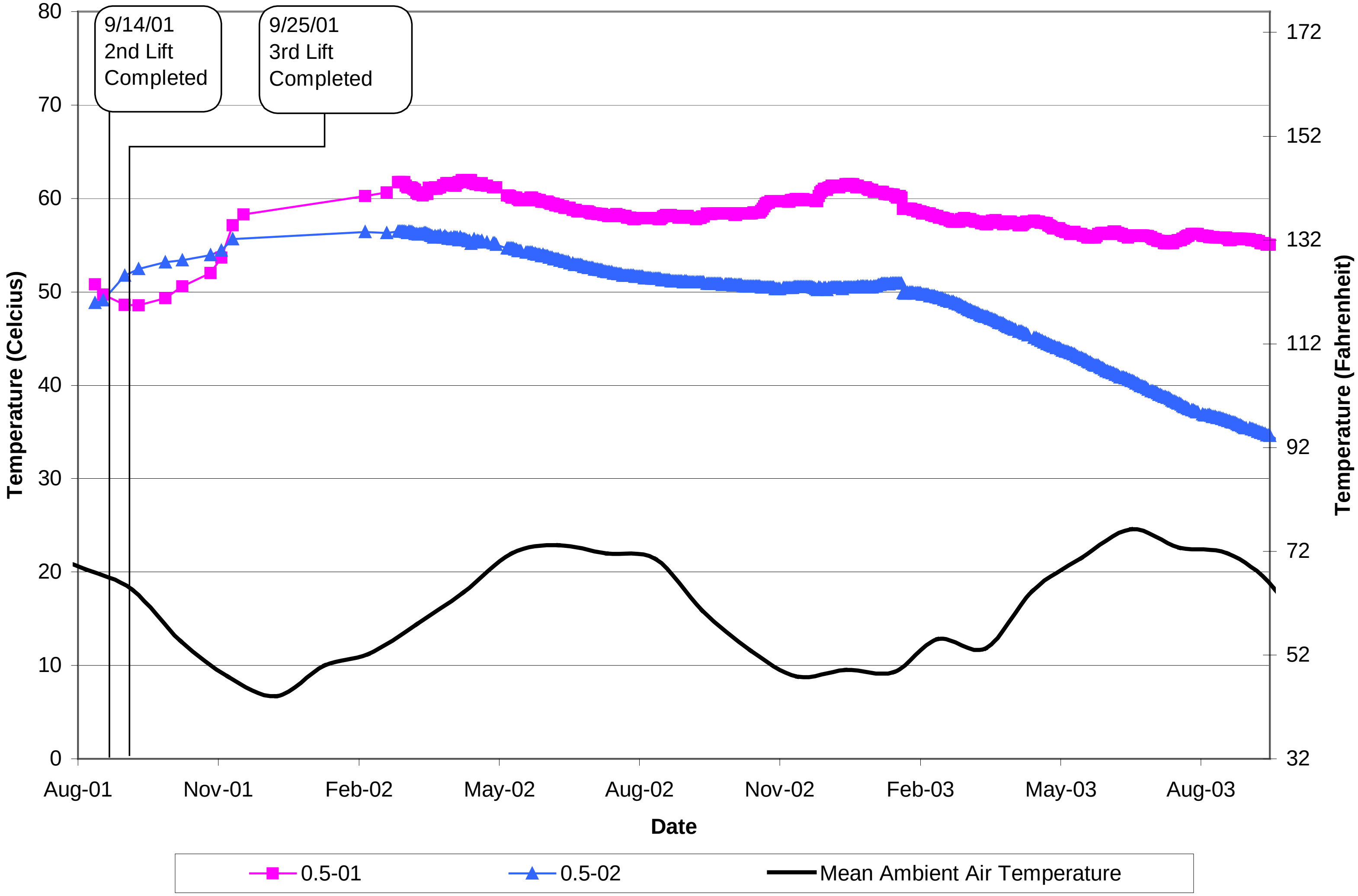


Figure 5-3. Aerobic Cell Layer 1 Temperature Readings

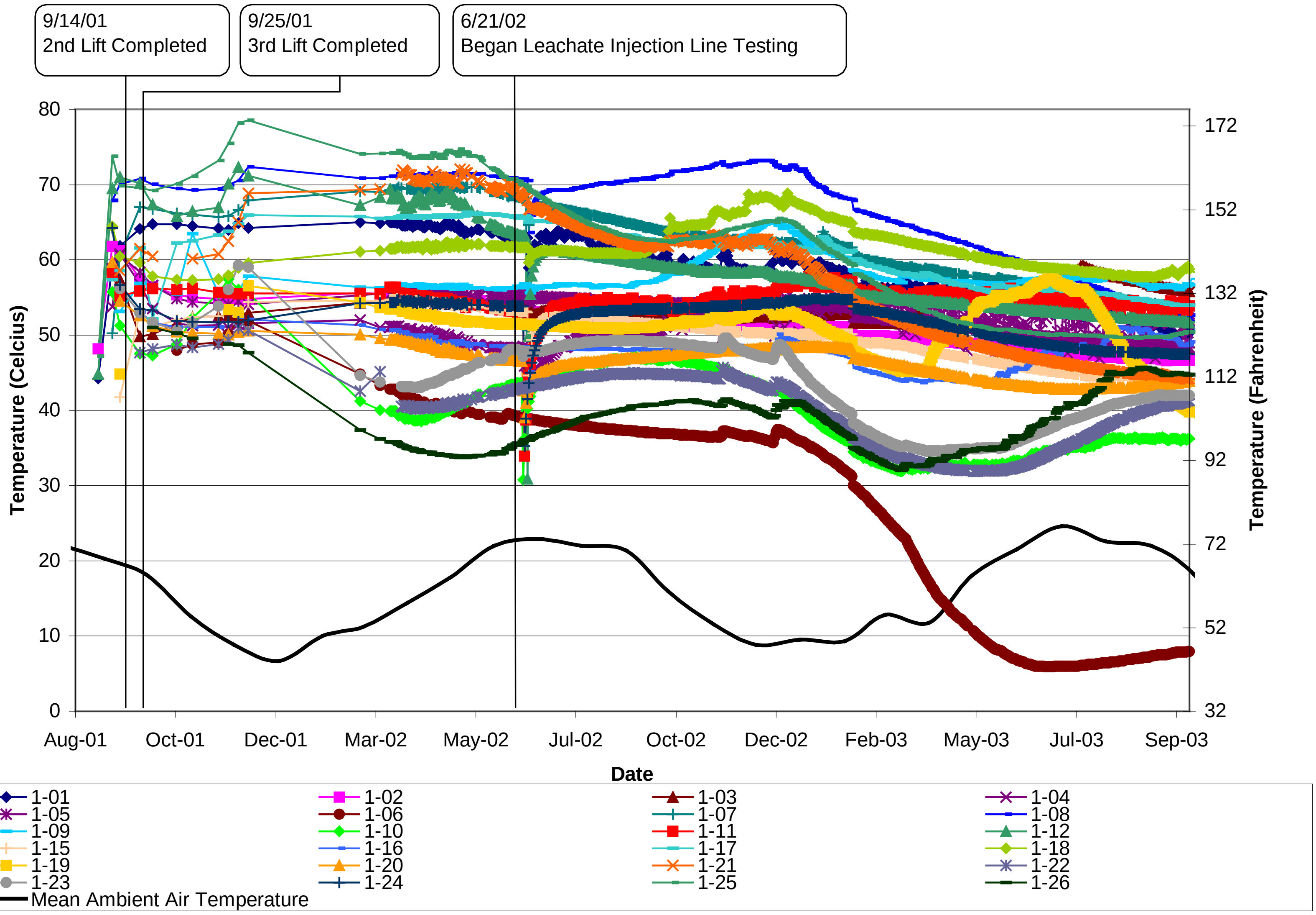


Figure 5-4. Aerobic Cell Layer 2 Temperature Readings

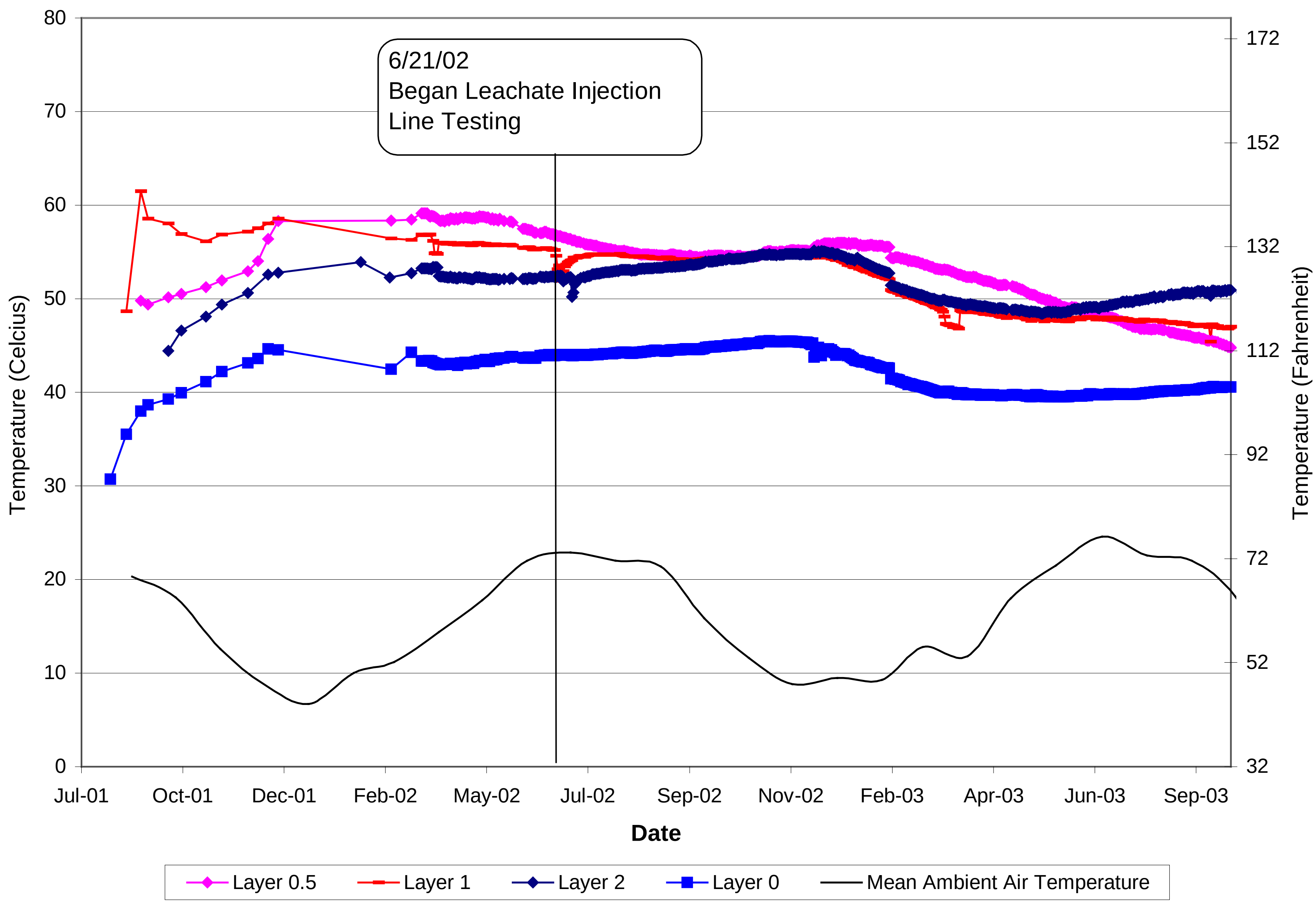


Figure 5-6. Aerobic Cell Base Liner PVC Moisture Readings

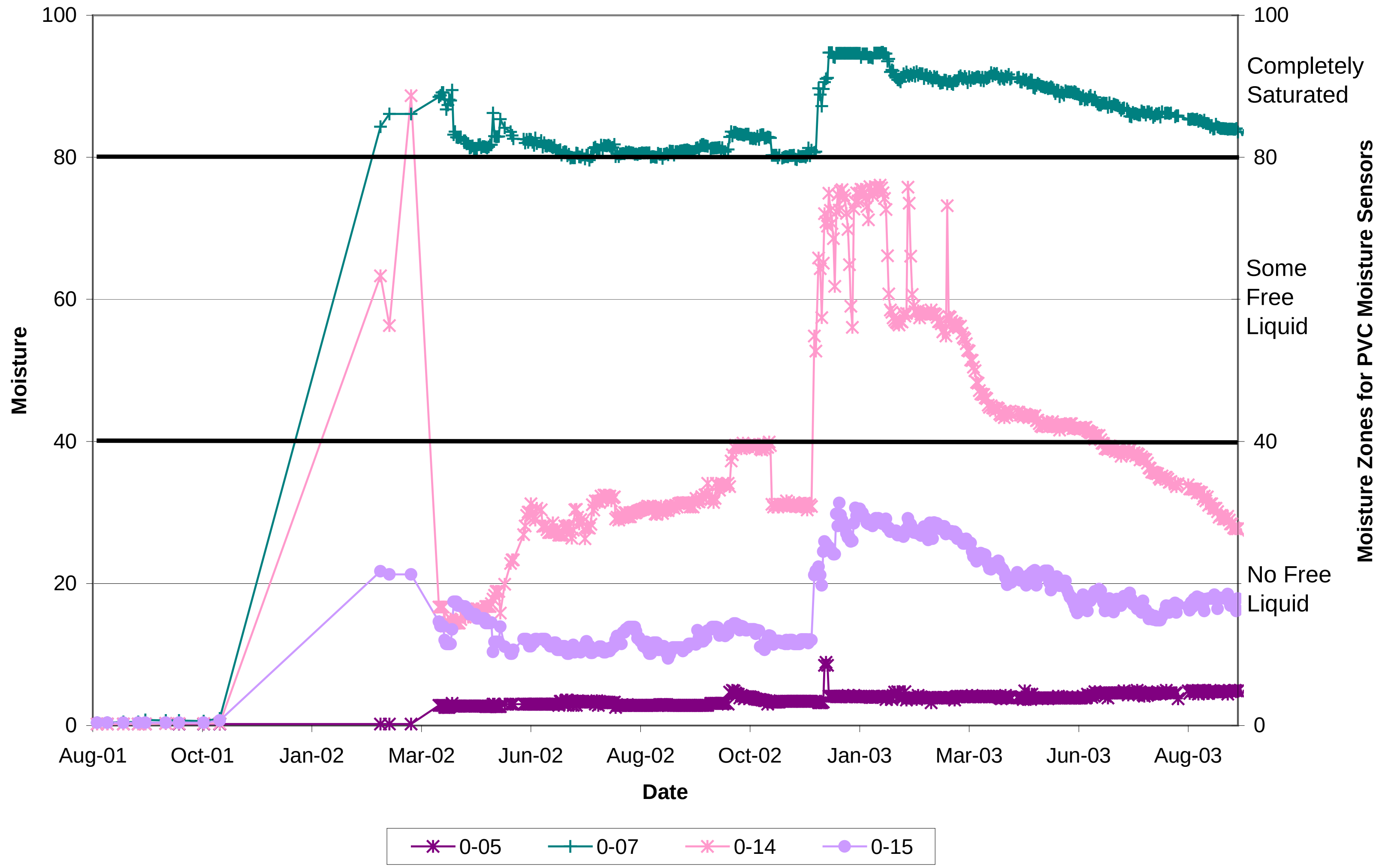


Figure 5-7. Aerobic Cell Layer 0.5 PVC Moisture Readings

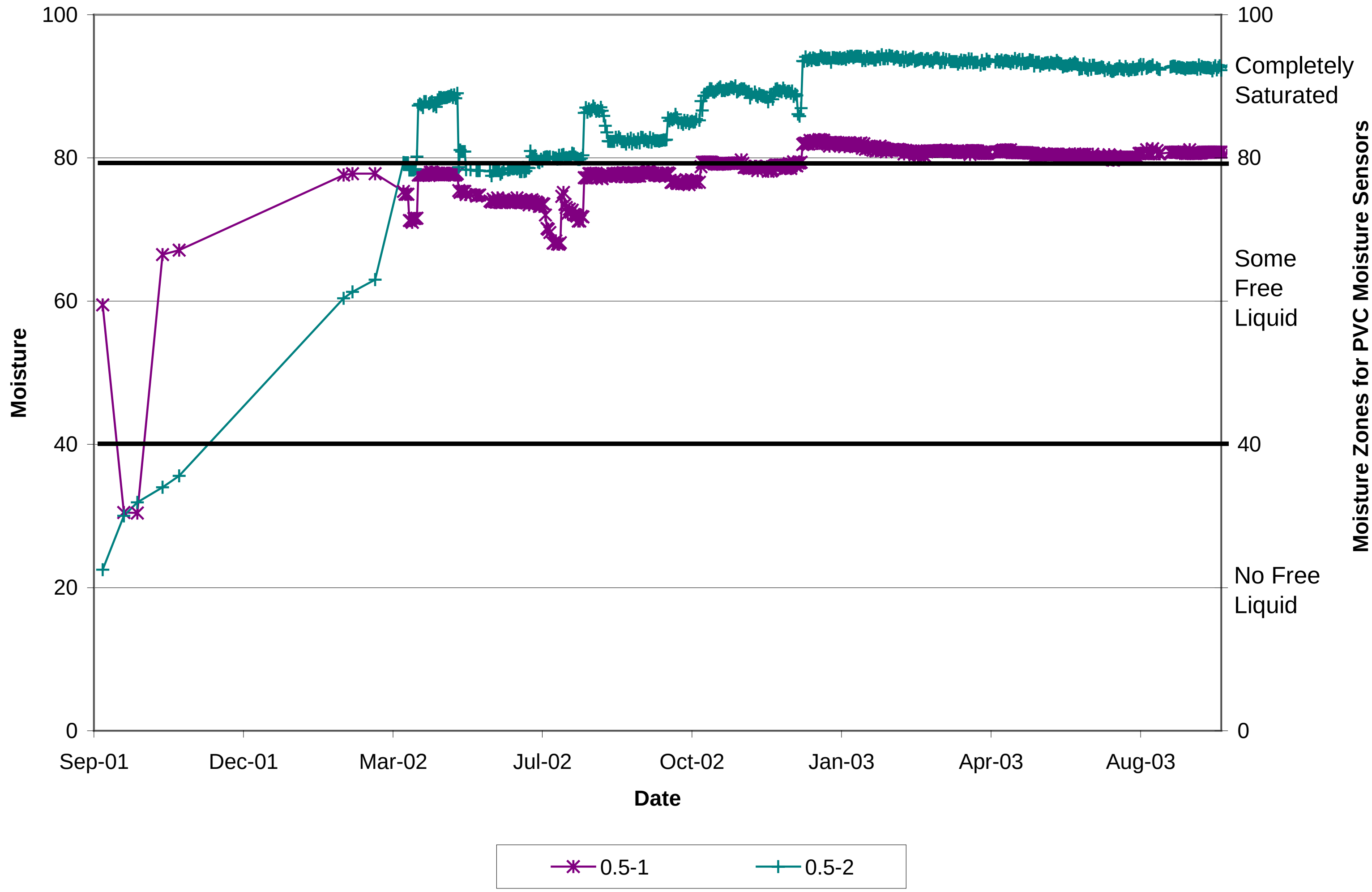


Figure 5-8. Aerobic Cell Layer 1 PVC Moisture Readings

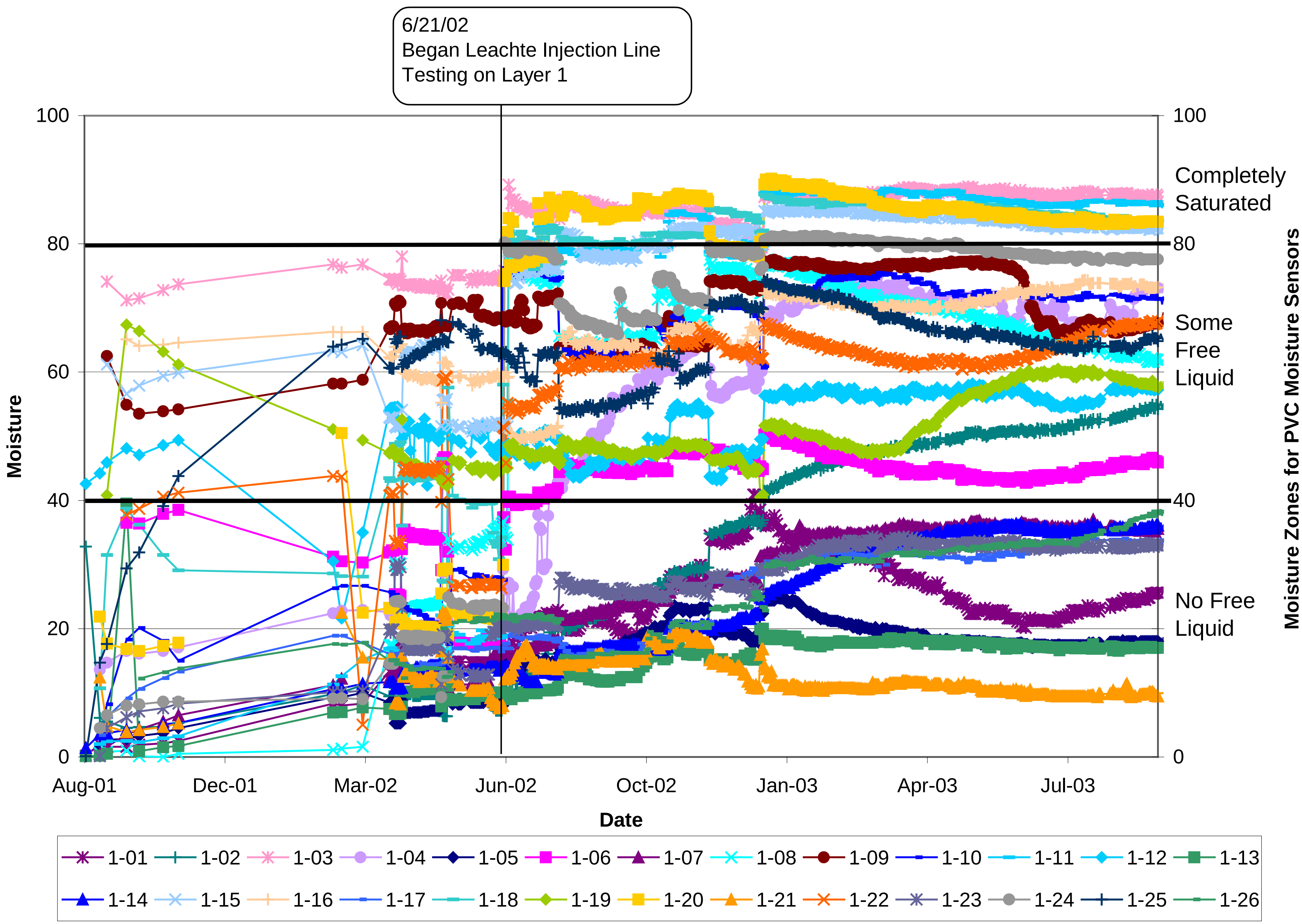


Figure 5-9. Aerobic Cell Layer 2 PVC Moisture Readings

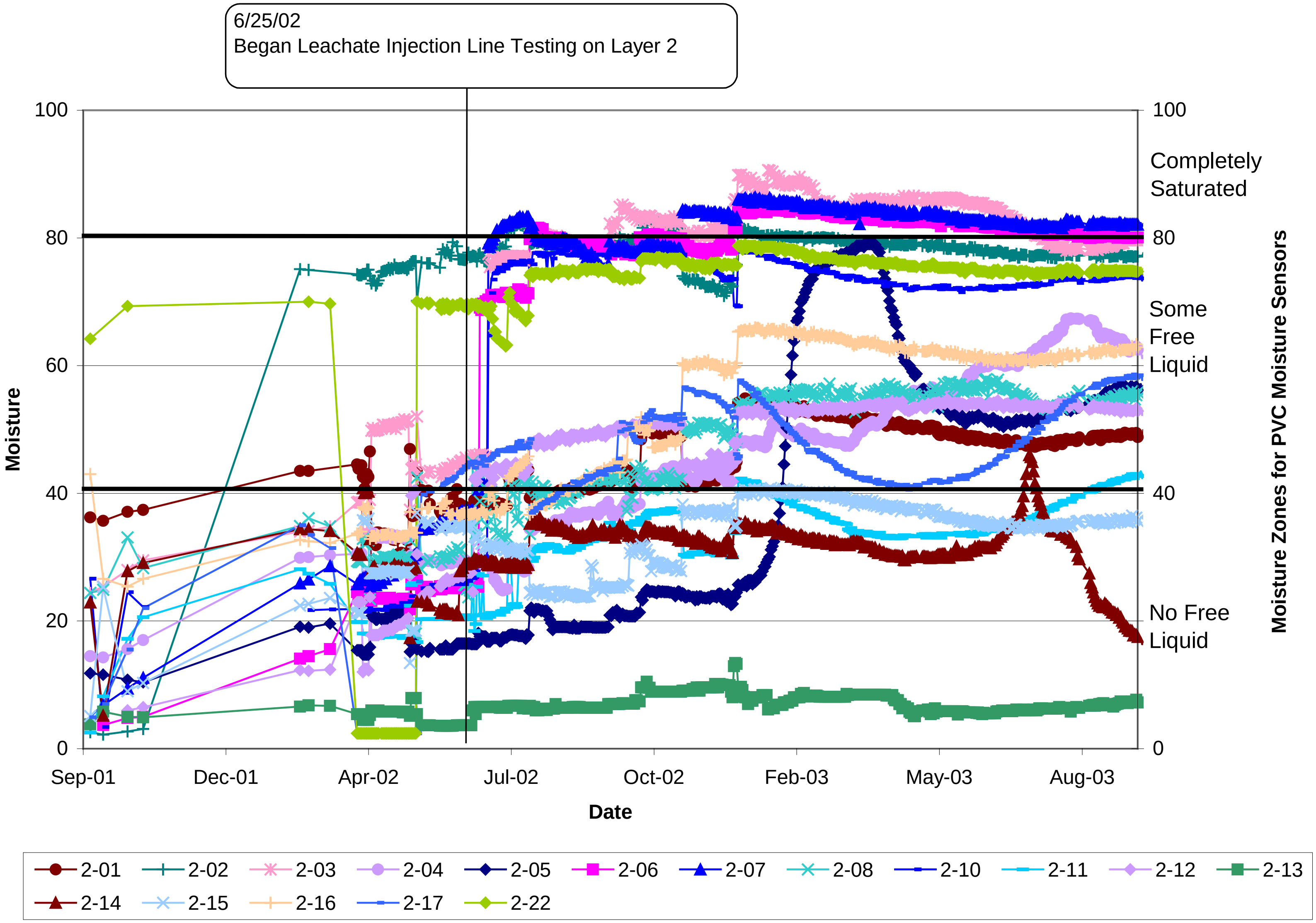


Figure 5-11. Aerobic Cell Landfill Gas Concentrations

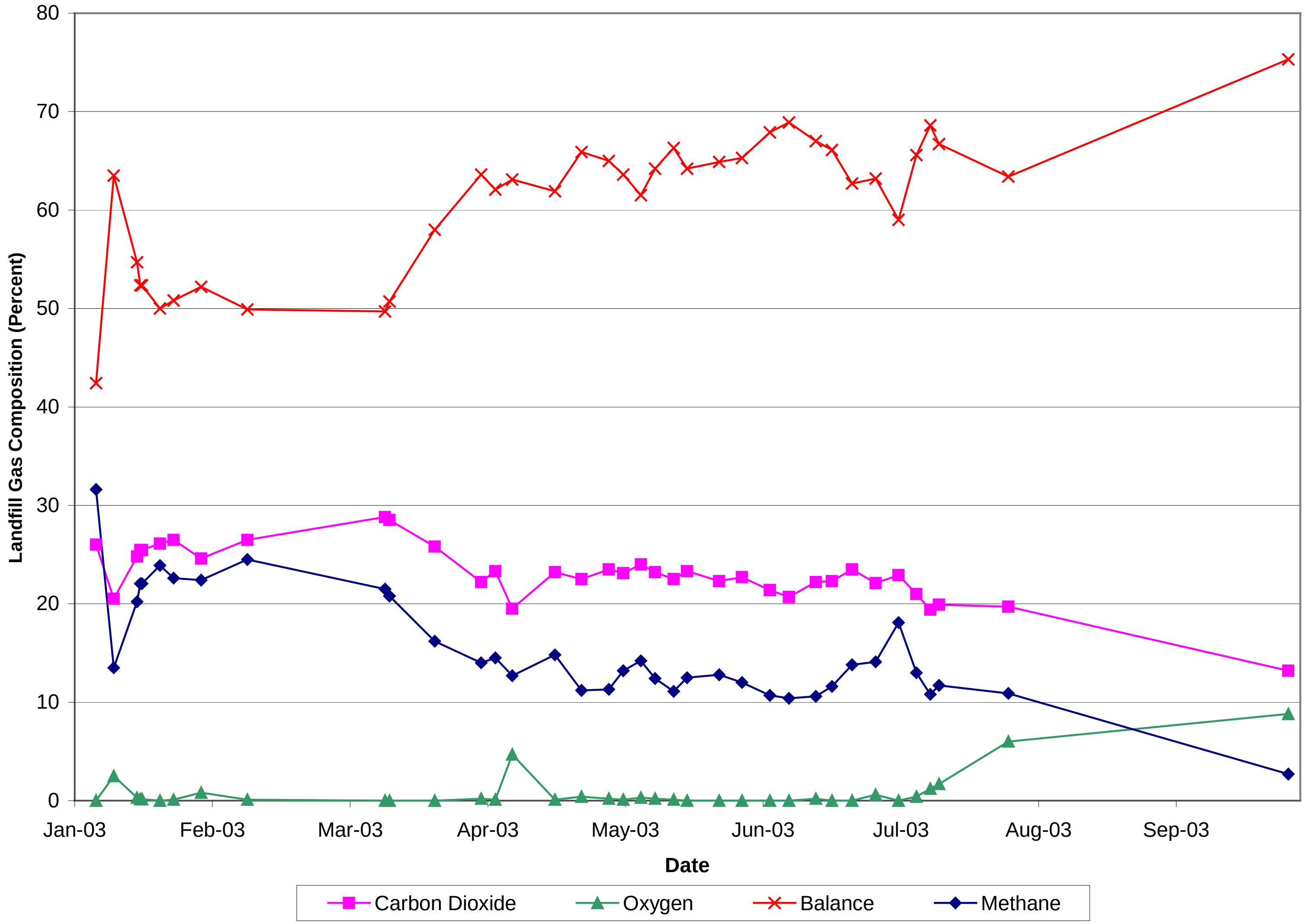


Figure 5-12. Aerobic Cell Landfill Gas Flow Rate

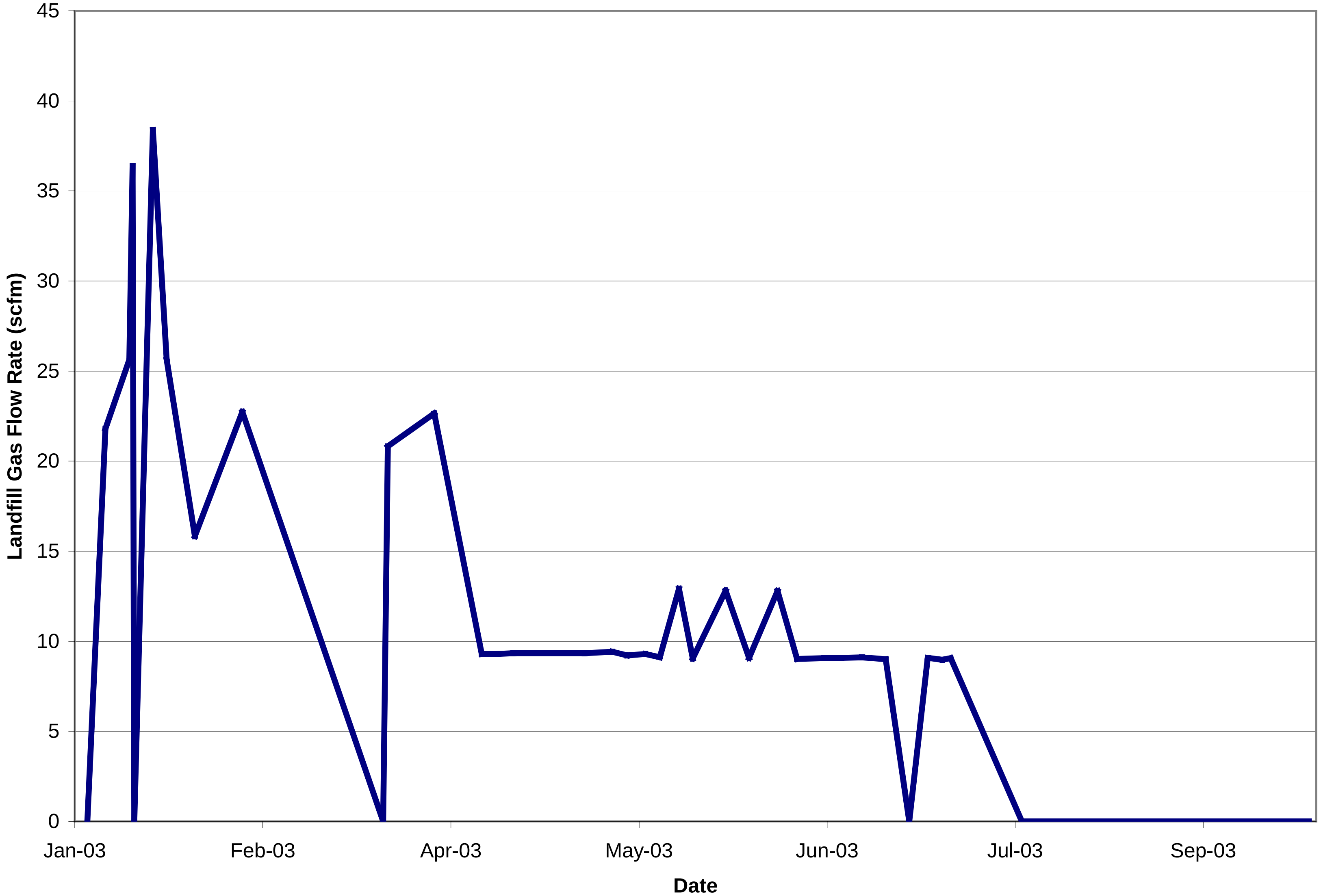


Figure 5-13. Aerobic Cell Cumulative Methane

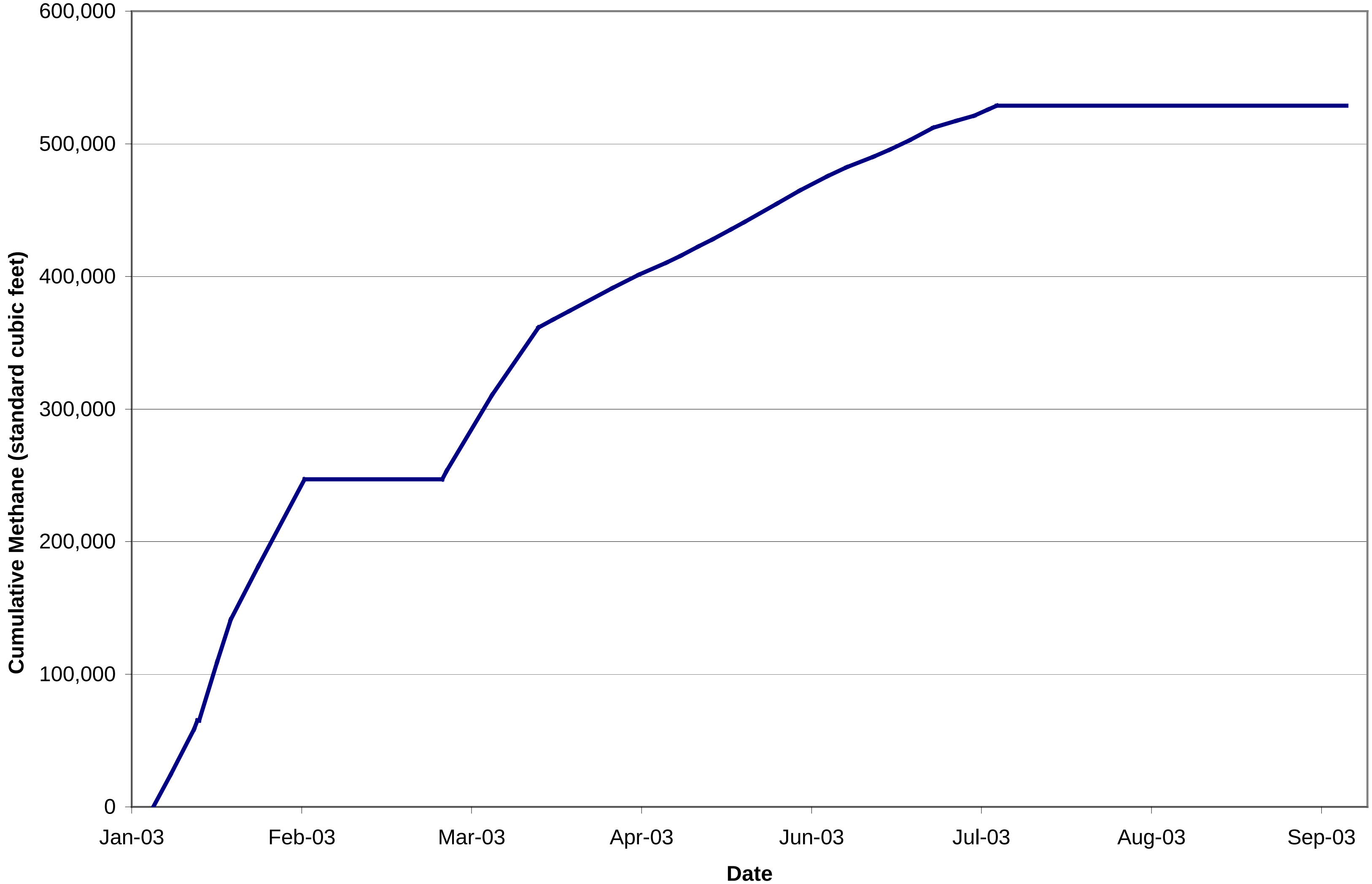


Figure 6-1. Module D Base Liner Temperature Readings (Northwest Quadrant)

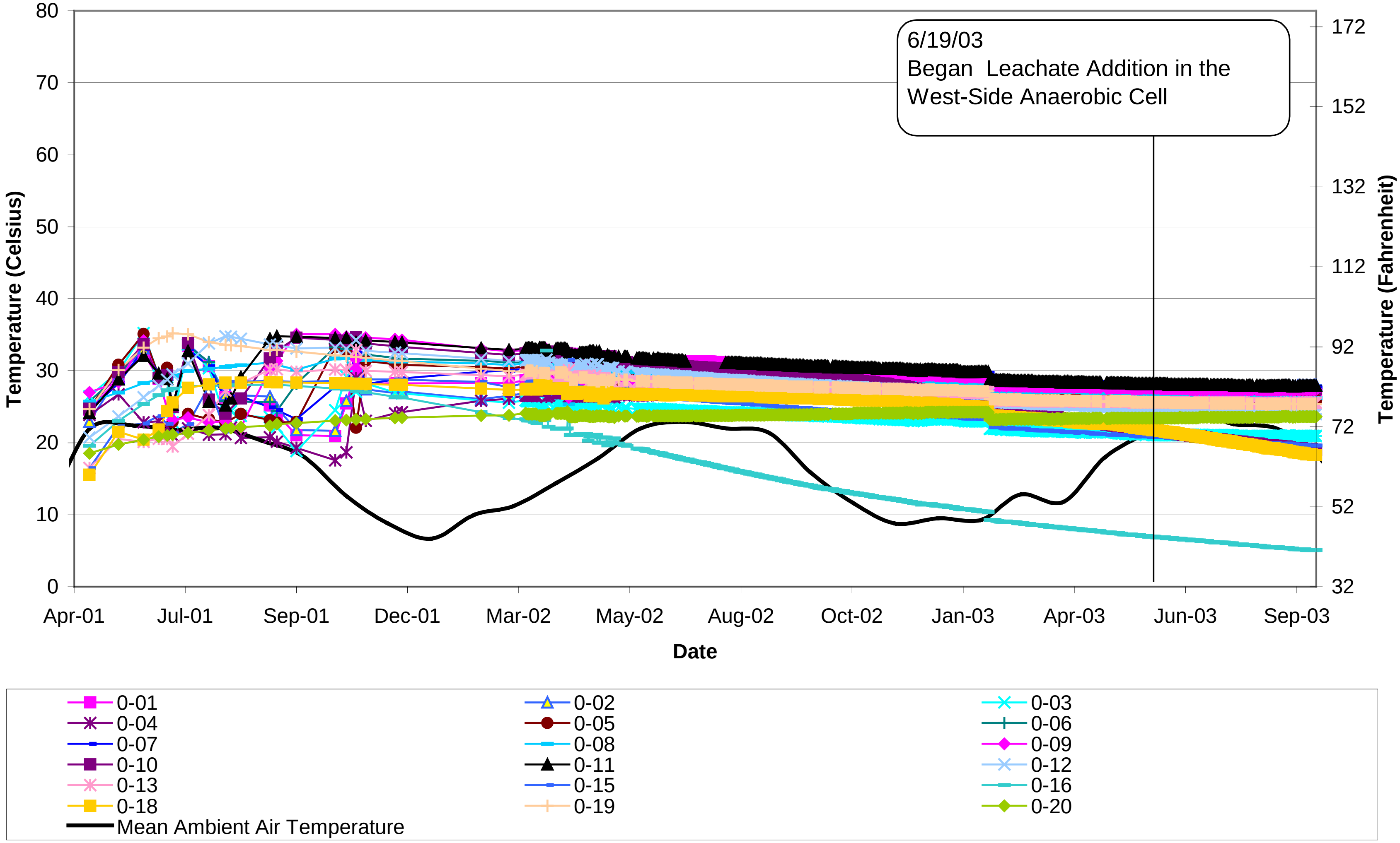


Figure 6-2. Module D Base Liner Temperature Readings (Southwest Quadrant)

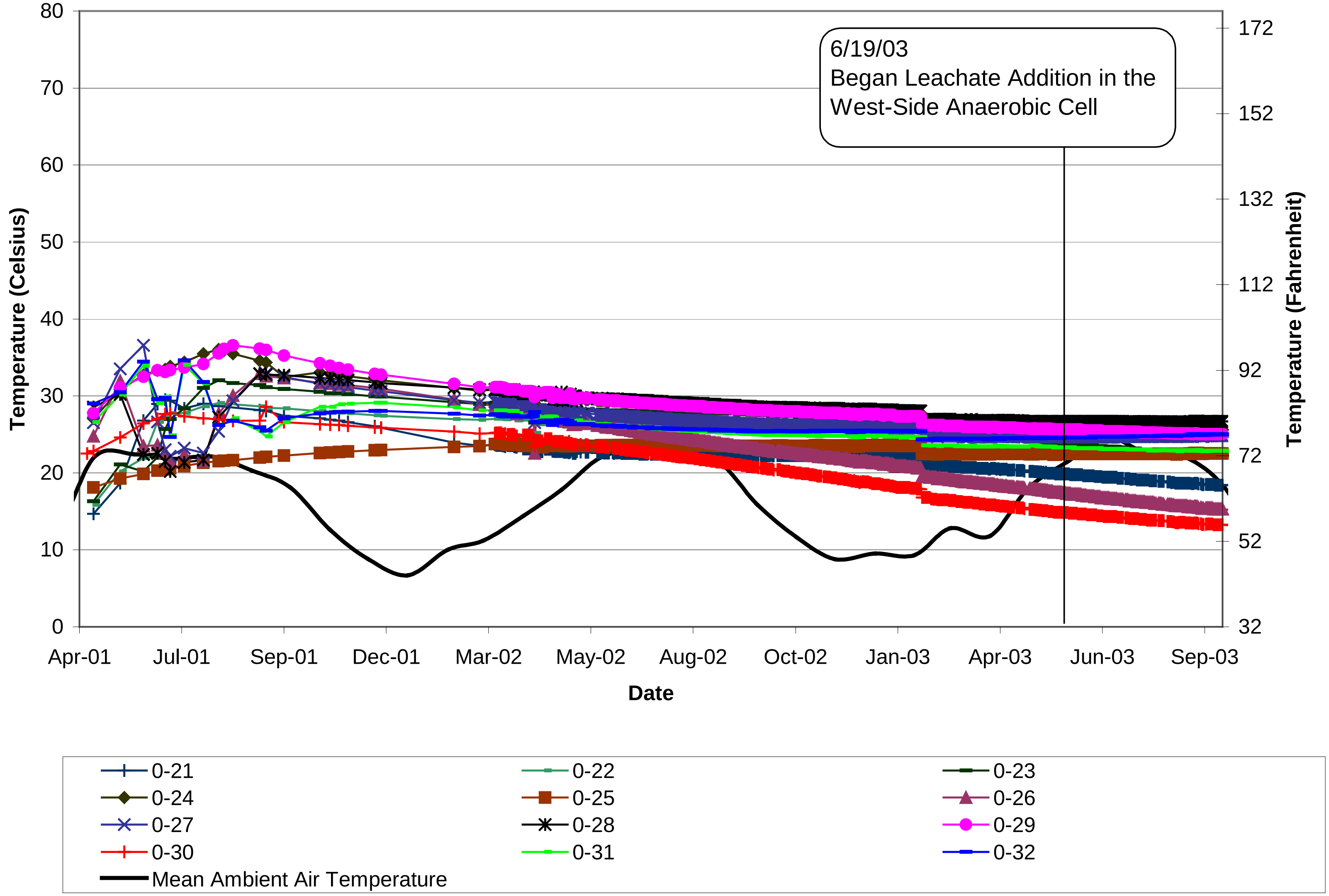


Figure 6-3. Module D Base Liner Temperature Readings (Northeast Quadrant)

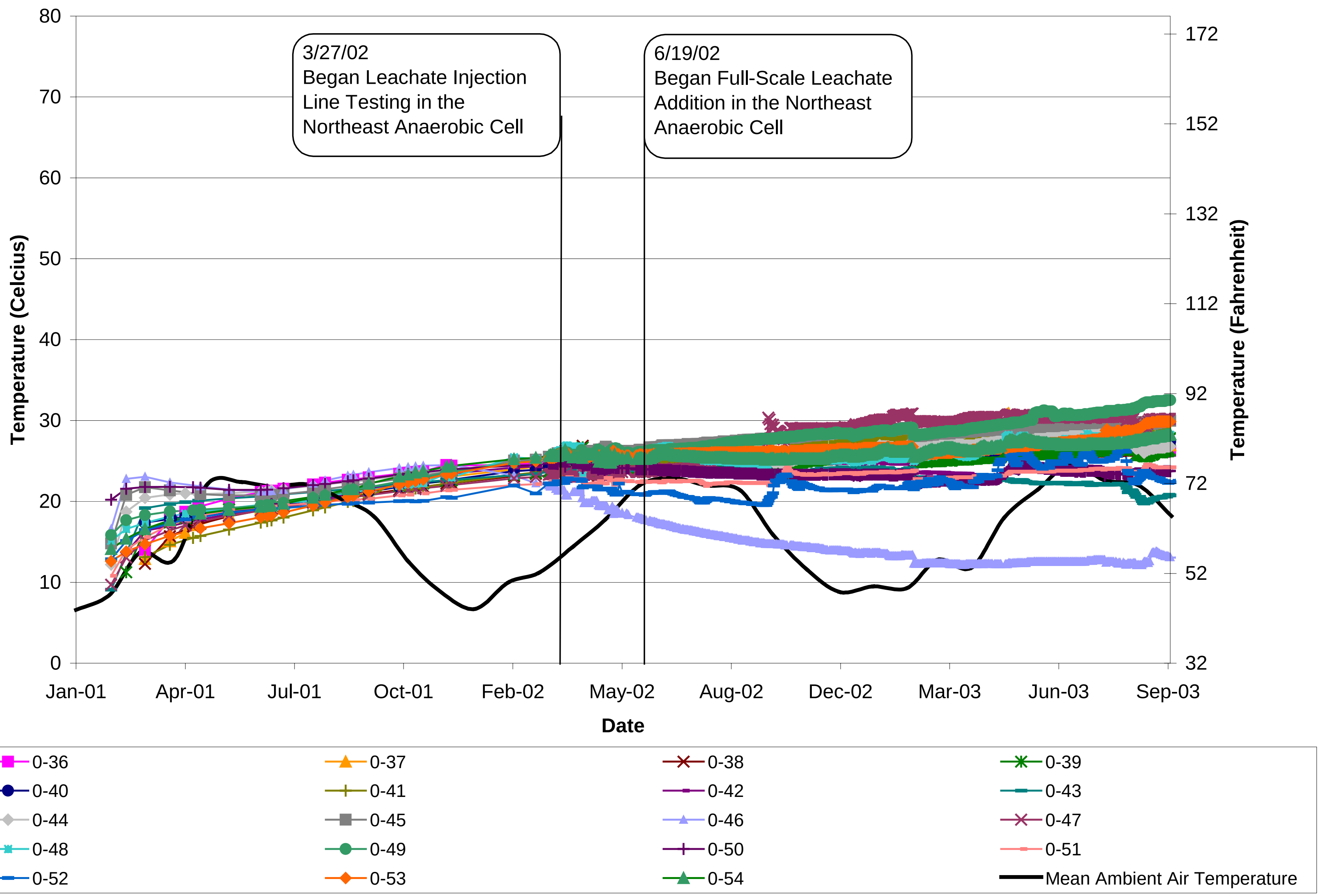


Figure 6-4. Module D Base Liner Temperature Readings (Southeast Quadrant)

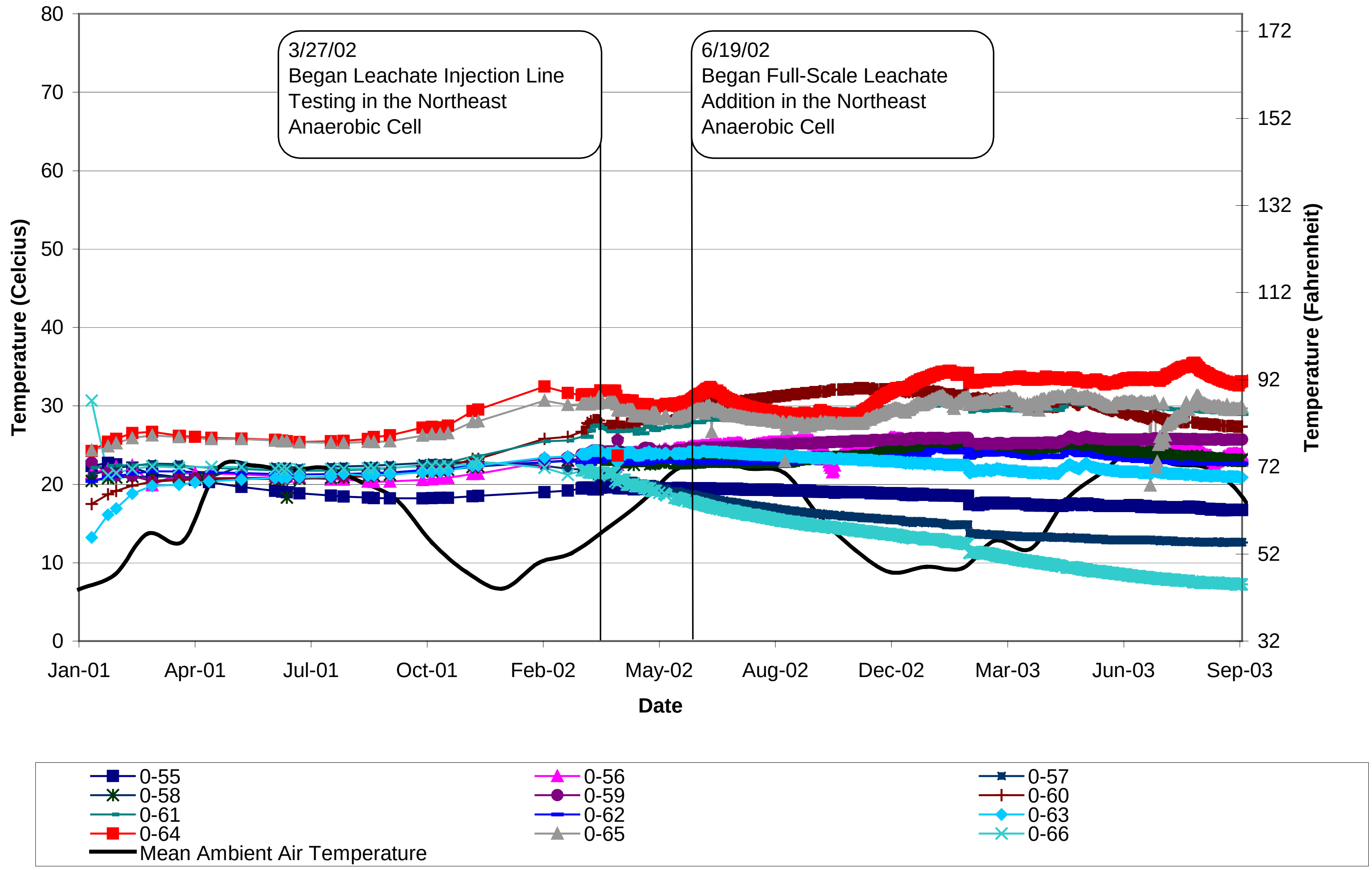


Figure 6-6. Module D Base Liner PVC Moisture Readings (Northwest and Southwest Quadrants)

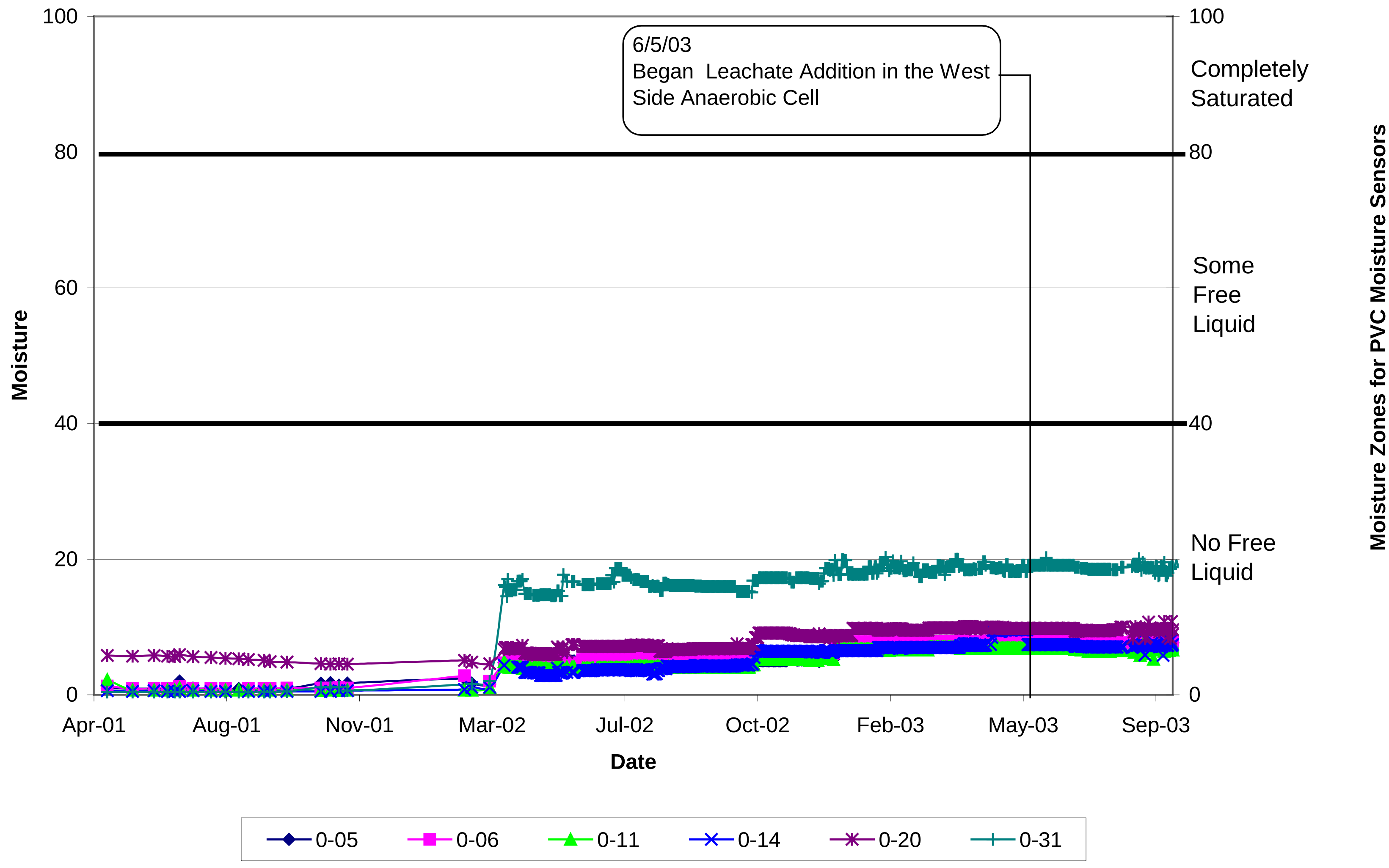


Figure 6-7. Module D Base Liner PVC Moisture Readings (Northeast Quadrant)

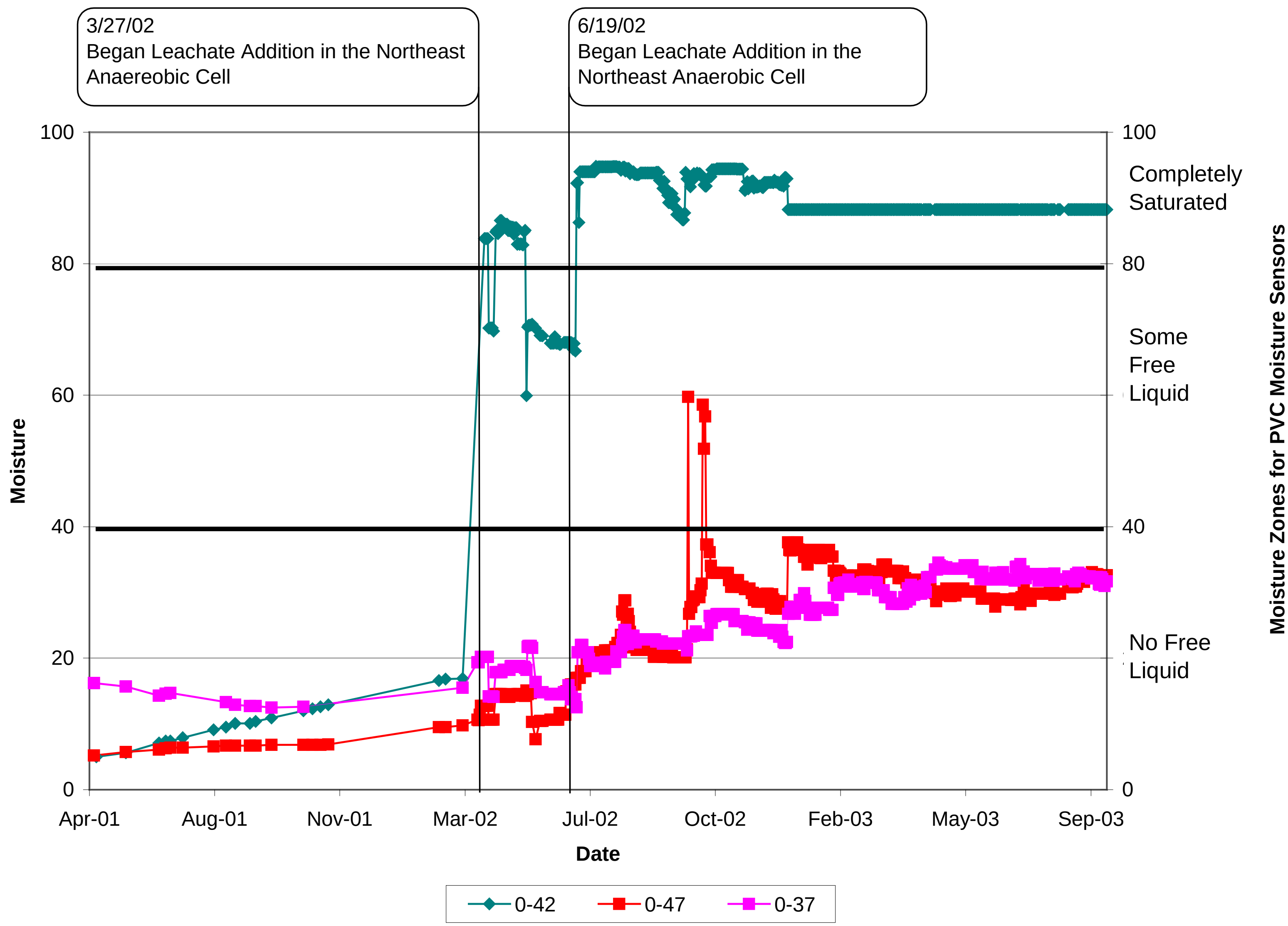


Figure 6-8. Module D Base Liner PVC Moisture Readings (Southeast Quadrant)

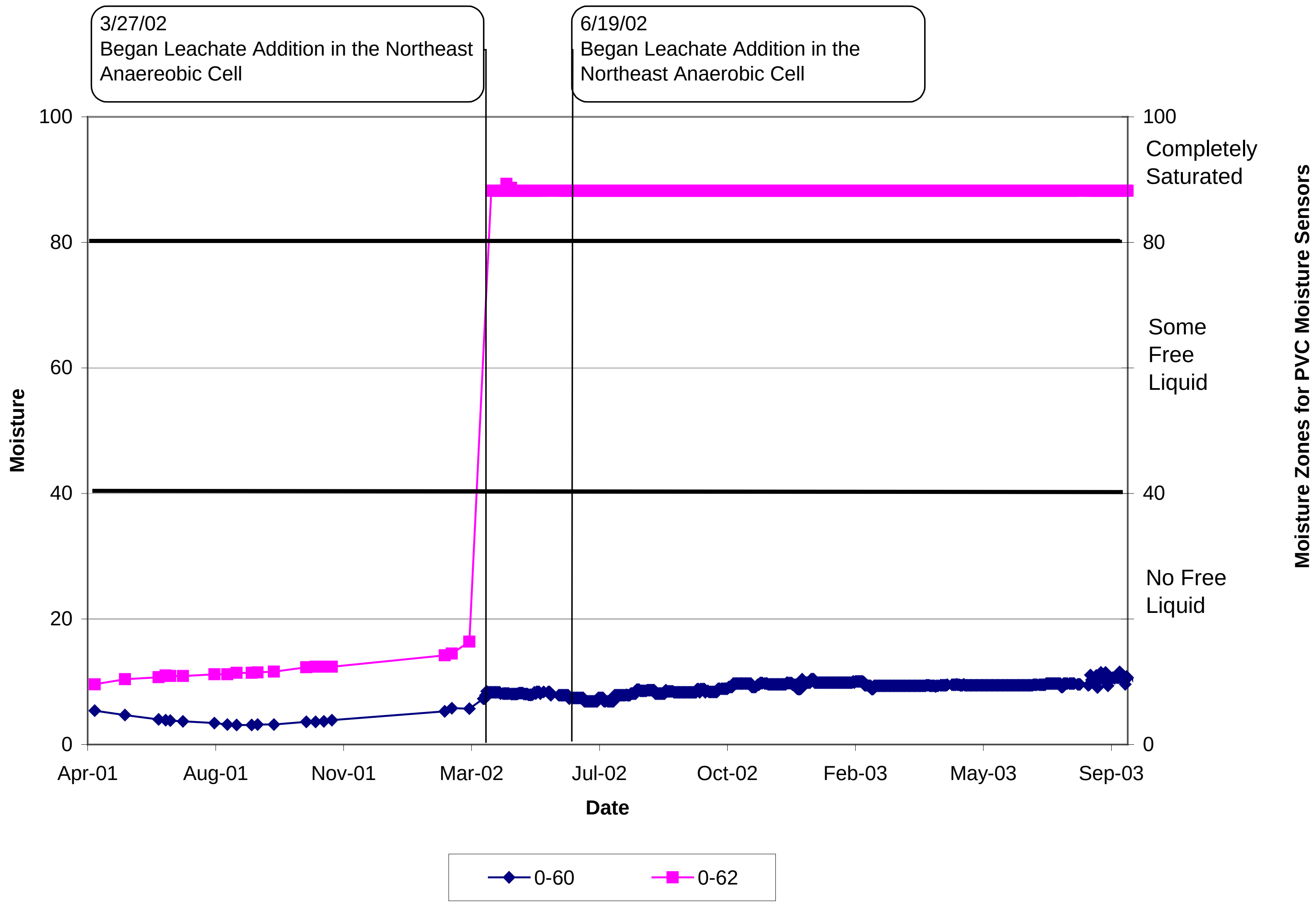
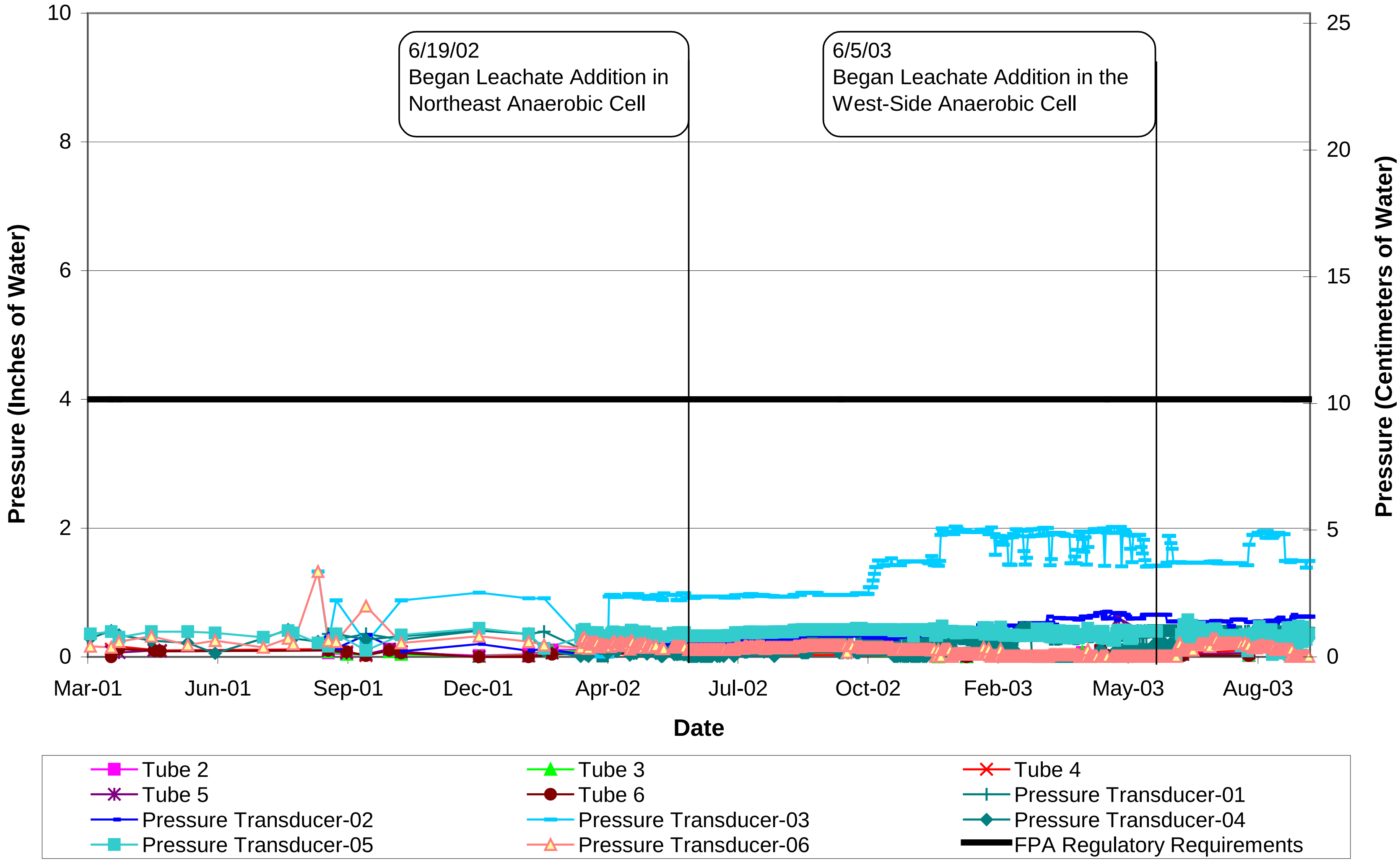


Figure 6-10. Module D Base Liner Pressure Transducers and Adjacent Tubes



APPENDIX D – LANDFILL GAS LABORATORY CHEMISTRY

Table 3-7. Analytical Results for Landfill Gas Sampled from the Northeast Anaerobic Cell and Pilot Scale Enhanced Cell

		Northeast Anaerobic Cell							Pilot Scale Cell
GAS ANALYSIS PARAMETERS	**DATE:**	**3/8/2002**	**5/29/2002**	**8/29/2002**	**12/5/2002**	**3/18/2003**	**5/27/2003**	**8/25/2003**	**Average of 3 samples during 2002**
Method CFR60 EPA 25C Mod:	**Units**								
Methane	ppm	280,000	280,000	460,000	400,000	390,000	450,000	530,000	466,667
Total Non-Methane Hydocarbons as Methane	ppm	10,000	9,500	6,200	3,000	1,600	1,500	1,400	680
Method CFR60A EPA 15/16:									
Dimethyl Sulfide	ppm	18	12	11	4.5	2.7	ND	0.91	ND
Hydrogen Sulfide	ppm	ND	ND	1.8	220	160	230	270	177
Carbonyl Sulfide	ppm	ND	ND	ND	0.47	0.43	ND	0.61	ND
Methyl Mercaptan	ppm	ND	ND	0.38	0.87	0.44	ND	0.36	ND
Ethyl Mercaptan	ppm	ND	ND	ND	ND	ND	ND	ND	ND
Carbon Disulfide	ppm	0.64	0.54	ND	ND	ND	ND	ND	ND
Dimethyl Disulfide	ppm	0.52	ND	ND	ND	ND	ND	ND	ND
Method CFR60 EPA 3C:									
Carbon Dioxide	%	41	41	43	37	40	37	42	37
Carbon Monoxide	%	ND	ND	ND	ND	ND	ND	ND	ND
Methane	%	28	28	46	40	39	45	53	47
Nitrogen	%	26	27	6.9	20	15	13	5.3	14
Oxygen	%	0.83	0.21	0.26	1.9	1.5	0.66	0.23	1
Method EPA-2 TO -15:									
Dichlorodifluormethane	ppb	7,900	6,400	1,400	1,300	1,200	680	410	303
Chloromethane	ppb	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloro-1,1,2,2-tetrafluoroethane	ppb	ND	400	320	110	85	68	ND	100
Vinyl Chloride	ppb	ND	950	3,600	4,000	1,200	1,200	840	167
Bromomethane	ppb	ND	ND	ND	ND	ND	ND	ND	ND
Chloroethane	ppb	1,100	820	550	360	170	160	ND	41
Trichlorofluoromethane	ppb	620	430	280	130	92	ND	ND	ND
1,1-Dichlorethane	ppb	ND	ND	ND	ND	ND	ND	ND	40
Carbon Disulfide	ppb	ND	ND	ND	ND	ND	ND	ND	ND

1,1,2-Trichloro-1,2,2-trifluoroethane	ppb	ND	ND	ND	ND	ND	ND	ND	66
Acetone	ppb	54,000	28,000	22,000	10,000	4,300	4,300	4,000	195
Methylene Chloride	ppb	14,000	8,200	3,900	1,200	300	160	72	ND
trans-1,2-Dichloroethene	ppb	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethane	ppb	1,600	1,000	850	340	130	95	72	45
Vinyl Acetate	ppb	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,2-Dichloroethane	ppb	ND	240	670	760	520	500	380	108
2-Butanone (MEK)	ppb	38,000	28,000	29,000	9,500	3,800	3,800	4,100	155
Chloroform	ppb	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	ppb	ND	ND	ND	ND	42	ND	ND	ND
Carbon Tetrachloride	ppb	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	ppb	1,700	1,800	1,500	960	380	450	310	89
1,2-Dichloroethane	ppb	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	ppb	1,700	1,300	1,200	620	260	240	200	39
1,2-Dichloropropane	ppb	ND	ND	ND	ND	ND	ND	ND	ND
Bromoodichloromethane	ppb	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,3-Dichloropropene	ppb	ND	ND	ND	ND	ND	ND	ND	ND
4-Methyl-2-Pentanone (MIBK)	ppb	10,000	9,700	8,100	2,500	760	760	570	ND
Toluene	ppb	31,000	26,000	25,000	19,000	8,400	8,400	7,000	1,400
trans-1,3-Dichloropropene	ppb	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	ppb	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	ppb	2,300	2,200	1,600	1,000	480	470	340	61
2-Hexanone	ppb	ND	ND	ND	ND	ND	ND	ND	ND
Dibromochloromethane	ppb	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dibromoethane (EDB)	ppb	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	ppb	ND	ND	ND	ND	ND	ND	ND	29
Ethylbenzene	ppb	2,800	3,200	3,000	3,100	1,800	1,800	1,800	1,633
Total Xylenes	ppb	9,400	11,000	9,700	9,700	5,200	5,600	4,900	2,933
Styrene	ppb	700	930	950	980	350	250(tr)	250	48
Bromoform	ppb	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	ppb	ND	ND	ND	ND	ND	ND	ND	ND
Benzyl Chloride	ppb	ND	ND	ND	ND	ND	ND	ND	ND
4-Ethyltoluene	ppb	ND	930	710	980	470	600	490	315
1,3,5-Trimethylbenzene	ppb	ND	290	260	390	170	210	190	203

1,2,4-Trimethylbenzene	ppb	ND	760	640	840	380	480	370	437
1,3-Dichlorobenzene	ppb	ND	ND	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	ppb	ND	270	190	280	66	78	ND	270
1,2-Dichlorobenzene	ppb	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	ppb	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorobutadiene	ppb	ND	ND	ND	ND	ND	ND	ND	ND

ND = Not Detected

Table 4-6. Analytical Results for Landfill Gas Sampled from the West-Side Anaerobic Cell and Aerobic Cell

		West-Side Anaerobic Cell				Aerobic Cell		
GAS ANALYSIS PARAMETERS	**Units**	**5/29/2002**	**3/18/2003**	**5/27/2003**	**8/25/2003**	**3/18/2003**	**5/27/2003**	**8/25/2003**
Method CFR60 EPA 25C Mod:								
Methane	ppm	230,000	180,000	310,000	460,000	100,000	63000	65,000
Total Non-Methane Hydocarbons as Methane	ppm	5,100	2,200	6,200	3,500	7,700	8100	7,500
Method CFR60A EPA 15/16:								
Dimethyl Sulfide	ppm	5.2	5	7	4.5	10	6.3	8.6
Hydrogen Sulfide	ppm	ND	66	81	270	ND	ND	ND
Carbonyl Sulfide	ppm	ND	0.91	0.81	1.2	ND	ND	0.2
Methyl Mercaptan	ppm	ND	1.3	1.5	1.8	1	0.95	0.4
Ethyl Mercaptan	ppm	ND	ND	ND	ND	ND	ND	ND
Carbon Disulfide	ppm	ND	0.89	0.52	0.38	ND	ND	ND
Dimethyl Disulfide	ppm	ND	ND	0.22	ND	0.84	1.1	0.96
Method CFR60 EPA 3C:								
Carbon Dioxide	%	68	19	34	39	24	21	22
Carbon Monoxide	%	ND	ND	ND	ND	ND	ND	ND
Methane	%	23	18	30	46	10	6.3	6.5
Nitrogen	%	11	49	31	14	62	68	69
Oxygen	%	ND	11	1.1	1	1.9	1.3	1.3
Method EPA-2 to-15								
Dichlorodifluormethane	ppb	17,000	3,800	2,700	1,300	1,400	ND	1,100
Chloromethane	ppb	ND	ND	ND	ND	ND	19	ND
1,2-Dichloro-1,1,2,2-tetrafluoroethane	ppb	1,100	340	240	ND	ND	ND	ND
Vinyl Chloride	ppb	1,200	170	180	1,500	ND	ND	ND
Bromomethane	ppb	ND	ND	ND	ND	ND	ND	ND
Chloroethane	ppb	780	320	380	ND	ND	ND	ND
Trichlorofluoromethane	ppb	7,900	370	370	ND	ND	ND	ND
1,1-Dichlorethane	ppb	880	440	620	250	580	ND	240
Carbon Disulfide	ppb	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloro-1,2,2-trifluoroethane	ppb	960	ND	ND	ND	ND	ND	ND

Acetone	ppb	13,000	16,000	22,000	12,000	50,000	90	42,000
Methylene Chloride	ppb	4,800	3,500	3,900	830	1,700	2.6	760
trans-1,2-Dichloroethene	ppb	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	ppb	ND	ND	ND	ND	ND	ND	ND
Vinyl Acetate	ppb	ND	ND	ND	ND	ND	ND	ND
cis-1,2-Dichloroethene	ppb	ND	290	310	530	ND	ND	ND
2-Butanone (MEK)	ppb	6,000	23,000	23,000	14,000	28,000	78	20,000
Chloroform	ppb	ND	ND	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	ppb	680	ND	ND	ND	ND	ND	ND
Carbon Tetrachloride	ppb	ND	ND	ND	ND	ND	ND	ND
Benzene	ppb	490	980	1,300	730	1,300	2.9	700
1,2-Dichloroethane	ppb	120	ND	150	ND	220	ND	ND
Trichloroethene	ppb	220	860	1,000	580	620	2.7	440
1,2-Dichloropropane	ppb	ND	ND	ND	ND	ND	ND	ND
Bromoodichloromethane	ppb	ND	ND	ND	ND	ND	ND	ND
cis-1,3-Dichloropropene	ppb	ND	ND	ND	ND	ND	ND	ND
4-Methyl-2-Pentanone (MIBK)	ppb	5,400	4,500	4,400	1,700	14,000	46	6,200
Toluene	ppb	3,400	21,000	22,000	13,000	20,000	130	11,000
trans-1,3-Dichloropropene	ppb	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	ppb	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	ppb	350	1,100	1,700	840	1,500	13	1,100
2-Hexanone	ppb	ND	ND	ND	ND	ND	ND	ND
Dibromochloromethane	ppb	ND	ND	ND	ND	ND	ND	ND
1,2-Dibromoethane (EDB)	ppb	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	ppb	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	ppb	170	5,100	3,600	1,800	2,300	52	2,400
Total Xylenes	ppb	480	14,000	11,000	5,000	6,500	200	7,000
Styrene	ppb	ND	890	1400	550	310	25	240
Bromoform	ppb	ND	ND	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	ppb	ND	ND	ND	ND	ND	ND	ND
Benzyl Chloride	ppb	ND	ND	ND	ND	ND	ND	ND
4-Ethyltoluene	ppb	ND	590	1100	400	500	45	480

1,3,5-Trimethylbenzene	ppb	ND	230	350	ND	ND	15	200
1,2,4-Trimethylbenzene	ppb	ND	370	750	260	370	47	330
1,3-Dichlorobenzene	ppb	ND	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	ppb	ND	ND	ND	ND	ND	21	ND
1,2-Dichlorobenzene	ppb	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	ppb	ND	ND	ND	ND	ND	ND	ND
Hexachlorobutadiene	ppb	ND	ND	ND	ND	ND	ND	ND

ND=Not Detected

APPENDIX E – LEACHATE LABORATORY CHEMISTRY

Table 3-8. Field Chemistry and Analytical Results for Leachate Sampled from the Northeast Anaerobic Cell

PARAMETER	**Date:**	**2/14/2002**	**3/27/2002**	**5/14/2002**	**6/20/2002**	**7/23/2002**	**8/13/2002**	**9/26/2002**	**10/17/2002**	**2/26/2003**	**5/27/2003**	**8/21/2003**
Field Parameters:	**Units**											
pH		7.13	7.55	7.40	7.60	7.44	7.48	7.47	7.35	8.16	7.02	7.55
Electrical Conductivity	µS	6583	6173	6095	4054	11510	15860	12440	10230	9351	11990	10650
Oxidation Reduction Potential	mV	-119	-12	80	94	-7	43	-35	-25	160	17	34
Temperature	C	19.9	21.5	25.9	26.5	30.5	30.5	28.4	26.0	23.5	33.3	33.3
Dissolved Oxygen	mg/L	0.65	2.13	1.4	2.04	0.33	1.31	3.66	2.96	5.56	2.80	3.00
Total Dissolved Solids	ppm	5244	4860	4059	3062	9740	14050	10770	8640	7850	9978	8673
General Chemistry:												
Bicarbonate Alkalinity	mg/L	1740	1550	1760	1110	3740	5150	3960	4010	2680	3280	3220
Carbonate Alkalinity	mg/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Total Alkalinity as CO_3	mg/L	1740	1550	1760	1110	3740	5150	3960	4010	2680	3280	3220
BOD	mg O/L	20	34	19	10	200	490	1400	3000	44	85	66
Chemical Oxygen Demand	mg O/L	633	488	791	196	1620	2820	2830	1810	120	1590	1010
Chloride	mg/L	1070	1100	1030	617	1950	2830	1870	1380	1470	1670	1650
Hydroxide	mg/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Ammonia as N	mg/L	30	24.4	26.3	13.5	131	264	255	289	132	207	158
Nitrate-Nitrite as N	mg/L	<0.03	0.43	<1.5	<0.015	0.061	0.22 (tr)	1.4	<0.009	17.3	13	7.6
Total Kjeldahl Nitrogen	mg/L	53.1	71	40	21.8	201	354	326	358	222	320	271
Sulfate	mg/L	322	210	94.3(tr)	256	5.3	8.2(tr)	155	7	315	45.3	243
Total Dissolved Solids @ 180 C	mg/L	4440	3960	3700	2500	7800	9860	8000	6680	5720	7700	6430
Total (Non-Volatile) Organic Carbon	mg/L	202	147	123	68.8	544	713	943	588	325	490	286
Total Phosphorus	mg/L	1.9	1.3	1.1	1.6	1.9	2.7	3.7	3.4	1.8	3.3	1
Total Sulfide	mg/L	1.3	0.18	1.3	0.74	1.2	2.5	1.1	1.4	0.034 (tr)	0.020 (tr)	<0.0093
Metals:												
Dissolved Aluminum	mg/L	0.14 (tr)	<0.043	0.10(tr)	<0.043	0.097(tr)	0.11(tr)	0.058(tr)	0.096 (tr)	0.063 (tr)	0.099 (tr)	0.098 (tr)
Dissolved Antimony	mg/L	0.0022	0.0015(tr)	0.0012(tr)	0.0008(tr)	0.012	<0.031	0.0089	0.0072	0.0072	0.0057	<0.031
Dissolved Arsenic	mg/L	0.029	0.026	0.028	0.037	0.054	0.062	0.058	0.062	0.043	0.06	0.046
Dissolved Barium	mg/L	0.84	0.56	0.92	0.39	1.6	1.6	2.5	1.7	0.88	1.2	1.1
Dissolved Beryllium	mg/L	<0.000078	<0.000078	<0.00078	<0.000078	<0.000078	<0.00009	<0.000078	<0.000078	<0.000078	<0.00039	<0.000090

Dissolved Boron	mg/L	7.9	7.1	7.4	NA	12.8	20.1	15.7	11.6	11.1	10.9	NA
Dissolved Cadmium	mg/L	<0.000074	<0.000074	<0.000074	<0.000074	<0.000074	<0.0031	<0.000074	<0.000074	0.00018 (tr)	0.00015 (tr)	<0.0031
Dissolvd Calcium	mg/L	183	137	158	NA	175	92	174	221	114	89.8	126
Dissolved Chromium	mg/L	0.036	0.024	0.025	0.0099	0.086	0.075	0.074	0.073	0.071	0.14	0.07
Dissolved Cobalt	mg/L	0.007	0.0058	0.0049	0.0034	0.011	0.014(tr)	0.018	0.016	0.037	0.048	0.028 (tr)
Dissolved Copper	mg/L	0.0054	0.004	0.002	0.0024	0.0052*	0.0043 (tr)	0.0044*	0.0044	0.03*	0.016	0.0053 (tr)
Dissolved Iron	mg/L	1.1	0.44	0.39	0.19	2.9*	1.8	3.9	4	2.5	2.8	2
Dissolved Lead	mg/L	0.00046(tr)	0.00016(tr)	0.00020(tr)	<0.000066	0.001	0.0016	0.0011	0.00078 (tr)	0.0014	0.004	0.0015
Dissolved Magnesium	mg/L	323	248	262	NA	535	655	480	437	359	265	365
Dissolved Manganese	mg/L	4.1	3.2	4.5	2.9	2	0.33	3	0.94	0.68	1.1	0.98
Dissolved Mercury	mg/L	<0.000049	<0.000049	<0.000049	<0.000049	<0.000049	0.000081(tr)*	<0.000049	<0.000049	<0.000064	<0.000064	<0.000064
Dissolved Molybdenum	mg/L	0.012(tr)	<0.0046	<0.0046	0.0048(tr)	0.0048 (tr)	<0.0046	<0.0046	<0.0046	0.013 (tr)	0.015 (tr)	NA
Dissolved Nickel	mg/L	0.13	0.14	0.13	0.08	0.26	0.3	0.23	0.2	0.38	0.4	0.26
Dissolved Potassium	mg/L	152	124	133	NA	215	336	319	348	371	372	307
Dissolved Phosphorus	mg/L	1.9	0.96	1.9	NA	1.6	2	3.6	2.6	1.8	3.3	1
Dissolved Selenium	mg/L	<0.0017	<0.0017	<0.0017	<0.0017	<0.0017	<0.0017	0.0077	<0.0017	0.002	<0.0017	<0.0017
Dissolved Silver	mg/L	0.000083 (tr)	0.000031 tr)	<0.00003	<0.00003	0.0002(tr)	<0.0032	0.0001(tr)	0.000061 (tr)	0.000084 (tr)	0.00018 (tr)	<0.0032
Dissolved Sodium	mg/L	875	774	759	NA	1370	2340	1820	1330	1440*	1410	1470
Dissolved Thallium	mg/L	<0.00034	<0.00034	<0.00034	<0.00034	<0.00034	<0.0034	<0.00034	<0.00034	<0.00034	<0.00034	<0.00034
Dissolved Tin	mg/L	<0.022	<0.022	<0.022	<0.022	<0.022	<0.022	<0.022	<0.022	0.0062 (tr)	0.058 (tr)	0.032 (tr)
Dissolved Vanadium	mg/L	0.059	0.03(tr)	0.031(tr)	0.013(tr)	0.21	0.1	0.071	0.054	0.061	0.093	0.072
Dissolved Zinc	mg/L	0.032	0.034	0.035	0.015	0.13(tr)	0.13	0.17	0.13	0.15	0.14	0.038
Volatile Organic Compounds:												
Acetone	µg/L	16	10	6.4	6.9	170*	1500 (tr)	2300	650	49	39	33 (tr)
Acrylonitrile	µg/L	<10	<10	<10	<10	<50	<100	<1000	<200	<20	<20	<32
Benzene	µg/L	<0.13	0.28 (tr)*	0.22(tr)	<0.13	<0.65	<1.3	<13	<2.6	0.36 (tr)	1.1 (tr)	<2.2
Bromobenzene	µg/L	<0.18	<0.18	<0.18	<0.18	<0.90	NA	<18	<3.6	<0.36	<0.36	NA
Bromochloromethane	µg/L	<0.31	<0.31	<0.31	<0.31	<1.6	<3.1	<31	<6.2	<0.62	<0.62	<2.0
Bromodichloromethane	µg/L	<0.14	<0.14	<0.14	<0.14	<0.70	<1.4	<14	<2.8	<0.28	<0.28	<2.2
Bromoform	µg/L	<0.10	<0.10	<0.10	<0.10	<0.50	<1.0	<10	<2.0	<0.20	<0.20	<3.6
Bromomethane (Methly bromide)	µg/L	<0.08	<0.08	0.68(tr)	<0.08	6.2*	<0.80	37(tr)*	<1.6	0.96 (tr)	<0.16	<1.8
2-Butanone (MEK)	µg/L	<1.0	<1.0	<1.0	1.1(tr)	240	2200	4300	1400	3.8 (tr)	<2.0	14 (tr)
n-Butylbenzene	µg/L	<0.12	<0.12	<0.12	<0.12	<0.60	NA	<12	<2.4	<0.24	<0.24	NA

sec-Butylbenzene	µg/L	<0.12	<0.12	<0.12	<0.12	<0.60	NA	<12	<2.4	<0.24	<0.24	NA
tert-Butylbenzene	µg/L	<0.14	<0.14	<0.14	<0.14	<0.70	NA	<14	<2.8	<0.28	<0.28	NA
Carbon Disulfide	µg/L	<1.0	<1.0	1.1(tr)	<1.0	<5.0	<10	<100	<20	<2.0	<2.0	<2.3
Carbon Tetrachloride	µg/L	<0.15	<0.15	<0.15	<0.15	<0.75	<1.5	<15	<3.0	<0.30	<0.30	<2.0
Chlorobenzene	µg/L	<0.12	<0.12	<0.12	<0.12	<0.60	<1.2	<12	<2.4	0.67 (tr)	1.1 (tr)	<1.8
Chloroethane	µg/L	<0.34	<0.34	<0.34	<0.34	<1.7	<3.4	<34	<6.8	<0.68	26	<2.4
Chloroform	µg/L	<0.12	<0.12	<0.12	<0.12	<0.60	<1.2	<12	7.5 (tr)	<0.24	<0.24	<2.3
Chloromethane (Methyl chloride)	µg/L	<0.25	<0.25	<0.25	<0.25	<1.2	<2.5	<25	<5.0	1.6 (tr)	<0.50	<2.9
2-Chlorotoluene	µg/L	<0.26	<0.26	<0.26	<0.26	<1.3	NA	<26	<5.2	<0.52	0.62 (tr)	NA
4-Chlorotoluene	µg/L	<0.10	<0.10	<0.10	<0.10	<0.50	NA	<10	<2.0	<0.20	<0.20	NA
Dibromochloromethane	µg/L	<0.40	<0.40	<0.40	<0.40	<2.0	<4.0	<40	<8.0	<0.80	<0.80	<2.8
1,2-Dibromo-3-chloropropane (DBCP)	µg/L	<0.22	<0.95	<0.95	<0.95	<4.8	<9.5	<95	<19	<1.9	<1.9	<5.9
1,2-Dibromoethane (EDB)	µg/L	<0.22	<0.21	<0.22	<0.22	<1.1	<2.2	<22	<4.4	<0.44	<0.44	<2.4
Dibromomethane (Methly bromide)	µg/L	<0.21	<0.21	<0.21	<0.21	<1.0	<2.1	<21	<4.2	<0.42	<0.42	<2.4
1,2-Dichlorobenzene	µg/L	<0.14	<0.14	<0.14	<0.14	<0.70	<1.4	<14	<2.8	<0.28	<0.28	<1.7
1,3-Dichlorobenzene	µg/L	<0.11	<0.11	<0.11	<0.11	<0.55	NA	<11	<2.2	<0.22	<0.22	<2.2
1,4-Dichlorobenzene	µg/L	<0.13	<0.13	<0.13	<0.13	<0.65	<1.3	<13	<2.6	<0.26	<0.26	<1.8
trans-1,4-Dichloro-2-butene	µg/L	<1.0	<1.0	<1.0	<1.0	<5.0	<10	<100	<20	<2.0	<2.0	<7.0
Dichlorodifluoromethane (Freon 12)	µg/L	<0.16	0.17(tr)	0.24(tr)	<0.16	<0.80	NA	<16	<3.2	<0.32	<0.32	<2.6
1,1-Dichloroethane (1,1-DCA)	µg/L	0.77(tr)	0.50(tr)	0.77(tr)	0.54(tr)	<0.50	<1.0	<10	<2.0	0.36 (tr)	0.55 (tr)	<2.9
1,2-Dichloroethane (1,2-DCA)	µg/L	<0.22	<0.22	<0.22	<0.22	<1.1	<2.2	<22	<4.4	<0.44	<0.44	<2.4
1,1-Dichloroethene (1,1-DCE)	µg/L	<0.36	<0.36	<0.36	<0.36	<1.8	<3.6	<36	<7.2	<0.72	<0.72	<2.4
cis-1,2-Dichloroethene (cis-1,2-DCE)	µg/L	0.58(tr)	1.2	1.8	1.5	2.3(tr)	1.8(tr)	<10	<2.0	<0.20	0.85 (tr)	<2.8
trans-1,2-Dichloroethene (trans-1,2-DCE)	µg/L	<0.11	<0.11	<0.11	<0.11	<0.55	<1.1	<11	<2.2	<0.22	<0.22	<2.7
1,2-Dichloropropane	µg/L	<0.15	<0.15	<0.15	<0.15	<0.75	<1.5	<15	<3.0	<0.30	<0.30	<2.0
1,3-Dichloropropane	µg/L	<0.20	<0.20	<0.20	<0.20	<1.0	NA	<20	<4.0	<0.40	<0.40	<2.6
2,2 Dichloropropane	µg/L	<0.13	<0.13	<0.13	<0.13	<0.65	NA	<13	<2.6	<0.26	<0.26	<2.1
1,1-Dichloropropene	µg/L	<0.14	<0.14	<0.14	<0.14	<0.70	NA	<14	<2.8	<0.28	<0.28	<2.0
cis-1,3-Dichloropropene	µg/L	<0.22	<0.22	<0.22	<0.22	<1.1	<2.2	<22	<4.4	<0.44	<0.44	<1.7
trans-1,3-Dichloropropene	µg/L	<0.30	<0.30	<0.30	<0.30	<1.5	<3.0	<30	<6.0	<0.60	<0.60	<1.9
Ethylbenzene	µg/L	<0.27	<0.27	<0.27	<0.27	<1.4	<2.7	<27	<5.4	<0.54	<0.54	<2.1
Hexachlorobutadiene	µg/L	<0.22	<0.22	<0.22	<0.22	<1.1	NA	<22	<4.4	<0.44	<0.44	<2.8
2-Hexanone (Methyl butyl	µg/L	<1.0	<1.0	<1.0	<1.0	<5.0	26	<100	<20	<2.0	<2.0	<3.4

ketone)												
Iodomethane (Methyl iodide)	µg/L	<1.0	<1.0	<1.0	<1.0	<5.0	<10	<100	<20	<2.0	<2.0	<1.9
Isopropylbenzene	µg/L	<0.12	<0.12	<0.12	<0.12	<0.60	NA	<12	<2.4	0.43 (tr)	1.0 (tr)	NA
p-Isopropyltoluene	µg/L	<0.13	<0.13	0.13(tr)	<0.13	<0.65	NA	<13	<2.6	<0.26	0.88 (tr)	NA
Methyl-tert-butyl ether (MTBE)	µg/L	14	10	16	6.3	44	76	150(tr)	110	8.7	10	37
4-Methyl-2-pentanone (MIBK)	µg/L	2	<1.0	<1.0	<1.0	100	520	1000	700	<2.0	<2.0	6.4 (tr)
Methylene Chloride	µg/L	1.5	<0.35	0.46(tr)	<0.35	<1.8	<3.5	<35	<7.0	<0.70	<0.70	<3.1
Naphthalene	µg/L	<0.15	0.45(tr)*	<0.15	<0.15	<0.75	NA	<15	<3.0	<0.30	0.77 (tr)	<1.8
n-Propylbenzene	µg/L	<0.15	<0.15	<0.15	<0.15	<0.75	NA	<15	<3.0	<0.30	<0.30	NA
Styrene	µg/L	<0.15	<0.15	<0.15	<0.15	<0.75	<30	<15	<3.0	<0.30	<0.30	<1.8
1,1,1,2-Tetrachloroethane	µg/L	<0.10	<0.10	<0.10	<0.10	<0.50	<20	<10	<2.0	<0.20	<0.20	<2.2
1,1,2,2-Tetrachloroethane	µg/L	<0.37	<0.37	<0.37	<0.37	<1.8	<74	<37	<7.4	<0.74	<0.74	<2.6
Tetrachloroethene (PCE)	µg/L	<0.38	0.84(tr)	<0.38	<0.38	<1.9	<76	<38	<7.6	<0.76	<0.76	<1.3
Toluene	µg/L	1.3*	0.98(tr)	2.9	0.44(tr)	8.3	<50	<25	24	<0.50	1.0 (tr)	9.1 (tr)
1,2,3-Trichlorobenzene	µg/L	<0.14	<0.14	<0.14	<0.14	<0.70	NA	<14	<2.8	<0.28	<0.28	NA
1,2,4-Trichlorobenzene	µg/L	<0.23	<0.23	<0.23	<0.23	<1.2	NA	<23	<4.6	<0.46	<0.46	NA
1,1,1-Trichloroethane (1,1,1-TCA)	µg/L	<0.41	<0.41	<0.41	<0.41	<2.0	<82	<41	<8.2	<0.82	<0.82	<2.0
1,1,2-Trichloroethane (1,1,2-TCA)	µg/L	<0.31	<0.31	<0.31	<0.31	<1.6	<62	<31	<6.2	<0.62	<0.62	<2.3
Trichloroethene (TCE)	µg/L	0.33(tr)	0.77(tr)	<0.31	0.46(tr)	<1.6	<62	<31	<6.2	<0.62	<0.62	<2.4
Trichlorofluoromethane (Freon 11)	µg/L	<0.23	<0.23	<0.23	<0.23	<1.2	<46	<23	<4.6	<0.46	<0.46	<2.8
1,2,3-Trichloropropane	µg/L	<0.30	<0.30	<0.30	<0.30	<1.5	<60	<30	<6.0	<0.60	<0.60	<3.4
1,2,4-Trimethylbenzene	µg/L	<0.12	<0.12	<0.12	<0.12	<0.60	NA	<12	<2.4	<0.24	<0.24	<1.6
1,3,5-Trimethylbenzene	µg/L	<0.14	0.27(tr)	<0.14	<0.14	<0.70	NA	<14	<2.8	<0.28	<0.28	NA
Vinyl Acetate	µg/L	<1.0	<1.0	<1.0	<1.0	<5.0	<200	<100	<20	<2.0	<2.0	<2.2
Vinyl Chloride	µg/L	<0.12	<0.12	0.30(tr)	<0.12	<0.60	<24	<12	<2.4	<0.24	<0.24	<2.9
Total Xylenes	µg/L	<0.10	0.13 (tr)	0.30(tr)	<0.10	<0.50	<20	<10	2.5 (tr)	<0.20	0.46 (tr)	<5.0

Footnotes:
NA=Not Analyzed
MDL=Method Detection Limit
PQL=Practical Quantification Limit
<=Less than the MDL
tr=trace: the amount detected was above the MDL but below the PQL
* = this parameter was alo detected in the method blank

Table 4-7. Analytical Results for Leachate Sampled from the West-Side Anaerobic Cell

PARAMETER	DATE:	2/14/2002	3/27/2002	5/14/2002	6/20/2002	7/23/2002	8/13/2002	2/26/2003	5/29/2003	6/26/2003	7/30/2003
Field Parameters:	**Units**										
pH		6.74	6.76	6.8	6.72	6.85	6.71	6.87	6.72	6.66	6.63
Electrical Conductivity	µS	3530	3868	3851	3944	3899	3810	2320	2687	3056	3265
Oxidation Reduction Potential	mV	-62	-59	-46	-19	-38	-36	-56	-33	-75	-55
Temperature	C	24.9	25.9	26.2	25.2	25.7	26.9	22.1	29.3	30.4	28.5
Dissolved Oxygen	mg/L	3.15	1.09	1.54	1.31	3.62	2.6	3.18	1.06	1.55	1.61
Total Dissolved Solids	ppm	2617	2886	2871	2960	2965	2908	1703	1933	2227	2398
General Chemistry:											
Bicarbonate Alkalinity	mg/L	1700	1790	1780	1730	1710	1680	1000	1070	1210	1260
Carbonate Alkalinity	mg/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Total Alkalinity as CO_3	mg/L	1700	1790	1780	1730	1710	1680	1000	1070	1210	1260
BOD	mg O/L	28	18	12	12	7.9	12	16	11	<6.0	10
Chemical Oxygen Demand	mg O/L	350	317	300	274	270	262	98.1	82.5	102	105
Chloride	mg/L	187	323	333	358	341	366	196	263	345	335
Hydroxide	mg/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Ammonia as N	mg/L	20.3	20	23.5	21.2	23.8	25	9.5	10.3	13.7	12.4
Nitrate-Nitrite as N	mg/L	0.016(tr)	<0.015	<1.5	<0.03	<0.015	<0.015	0.022 (tr)	<0.18	<0.09	<0.25
Total Kjeldahl Nitrogen	mg/L	32.6	68.9	31.1	31.5	31.4	31	13.8	15.7	19.1	15.7*
Sulfate	mg/L	1.7(tr)	1.5(tr)	<10	0.80(tr)	2.2	0.75(tr)	<0.70	3.4 (tr)	<0.28	1.2 (tr)
Total Dissolved Solids @ 180 C	mg/L	2220	2380	2320	2410	2310	2280	1320	1480	1700	1840
Total (Non-Volatile) Organic Carbon	mg/L	112	95.7	85.2	86.5	82.7	78.1	28.3	25.5	37.9	34.4
Total Phosphorus	mg/L	0.13	1.6*	1.1	0.6	0.057	0.049(tr)	<0.12	<0.12	<0.12	0.38
Total Sulfide	mg/L	0.033(tr)	0.015(tr)	<0.014	<0.014	0.023 (tr)	<0.014	<0.0093	<0.0093	<0.0093	<0.0093
Metals:											
Dissolved Aluminum	mg/L	0.13(tr)	<0.043	0.053(tr)*	<0.043	<0.043	<0.043	<0.043	<0.043	<0.043	<0.043
Dissolved Antimony	mg/L	0.0013(tr)	0.00091(tr)	0.00065(tr)	0.0006 (tr)	0.0008(tr)	<0.031	0.00090 (tr)	0.00074 (tr)	0.00036 (tr)	0.00029 (tr)
Dissolved Arsenic	mg/L	0.27	0.02	0.018	0.019	0.017	0.01	0.012	0.012	0.0028	0.013
Dissolved Barium	mg/L	1.8	1.8	0.45	1.8	1.6	1.4	1.1	1	1.3	1.3
Dissolved Beryllium	mg/L	<0.000078	<0.000078	<0.000078	<0.000078	<0.000078	<0.00009	<0.000078	<0.00039	<0.000078	<0.000078

Dissolved Boron	mg/L	3.2	3.5	18.9	NA	3.7	3.2	<0.000078	3.6	4.2	4.2
Dissolved Cadmium	mg/L	<0.000074	<0.000074	<0.000074	<0.000074	<0.000074	<0.0031	<0.000074	<0.000074	<0.000074	0.0011
Dissolvd Calcium	mg/L	241	234	58.2	NA	231	193	108	115	131	132
Dissolved Chromium	mg/L	0.0088	0.0069	0.0064	0.0059	0.0054	0.0035(tr)	0.0019 (tr)	0.0033	0.0021	0.0023
Dissolved Cobalt	mg/L	0.0038	0.0043	0.003	0.0025	0.0025	<0.0074	0.0015	0.0039 (tr)	0.0021	0.0026
Dissolved Copper	mg/L	0.0018(tr)	0.0022	0.0011(tr)*	0.002	0.0023	0.0035(tr)	0.002*	0.0018 (tr)	0.0035	0.0062*
Dissolved Iron	mg/L	0.4	1.2	0.035(tr)*	1.9	0.59	0.11	0.15	0.11	0.064 (tr)	0.077 (tr)
Dissolved Lead	mg/L	0.00024 (tr)	0.000066(tr)	0.000078(tr)*	<0.000066	<0.000066	<0.000066	<0.000066	0.00026 (tr)	<0.000066	0.0019
Dissolved Magnesium	mg/L	198	211	343	NA	217	185	123	143	162	173
Dissolved Manganese	mg/L	24.6	22.9	0.0062(tr)	21.4	19.3	15.9	10.9	9.8	11.3	10.6
Dissolved Mercury	mg/L	<0.000049	<0.000049	<0.000049	<0.000049	<0.000049	0.000078 (tr)*	<0.000064	0.000083 (tr)	<0.000064	<0.000064
Dissolved Molybdenum	mg/L	<0.0046	<0.0046	0.044	<0.0046	<0.0046	<0.0046	<0.0046	0.0084 (tr)	<0.0046	<0.0046
Dissolved Nickel	mg/L	0.042	0.053	0.052	0.047	0.046	0.041	0.018	0.026	0.027	0.026
Dissolved Potassium	mg/L	55.2	48.3	58.6	NA	37.8	32.5	23.7	20.1	23.8	22.8
Dissolved Phosphorus	mg/L	0.28(tr)	0.14(tr)	1	NA	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12
Dissolved Selenium	mg/L	<0.0017	<0.0017	<0.0017	<0.0017	0.002	<0.0017	<0.0017	<0.0017	<0.0017	0.0023
Dissolved Silver	mg/L	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003	<0.0032	<0.000030	<0.000030	<0.000030	<0.000030
Dissolved Sodium	mg/L	260	281	1500*	NA	268	234	226	266	282	309
Dissolved Thallium	mg/L	<0.00034	<0.00034	<0.00034	<0.00034	<0.00034	<0.00034	<0.00034	<0.00034	<0.00034	<0.00034
Dissolved Tin	mg/L	<0.022	<0.022	<0.022	<0.022	<0.022	<0.022	<0.0014	0.048 (tr)	0.023 (tr)	<0.0014
Dissolved Vanadium	mg/L	0.0056(tr)	0.0038(tr)	0.017(tr)	<0.0032	<0.0032	<0.0032	<0.0032	<0.0032	<0.0032	<0.0032
Dissolved Zinc	mg/L	0.068	0.07	0.039	0.037	0.05	0.006(tr)	0.042	0.042	0.043	0.042
Volatile Organic Compounds:											
Acetone	µg/L	<50	28	22	22	14(tr)*	33 (tr)	13 (tr)	33 (tr)	15 (tr)	21 (tr)
Acrylonitrile	µg/L	<500	<100	<100	<100	<50	<100	<50	<50	<50	<50
Benzene	µg/L	<6.5	3.3(tr)*	2.3(tr)	<1.3	3.5(tr)	3.6(tr)	2.6 (tr)	2.4 (tr)	3.2 (tr)	3.3 (tr)
Bromobenzene	µg/L	<9.0	<1.8	<1.8	<1.8	<0.90	NA	<0.90	<0.90	<0.90	<0.90
Bromochloromethane	µg/L	<16	<3.1	<3.1	<3.1	<1.6	<3.1	<1.6	<1.6	<1.6	<1.6
Bromodichloromethane	µg/L	<7.0	<1.4	<1.4	<1.4	<0.70	<1.4	<0.70	<0.70	<0.70	<0.70
Bromoform	µg/L	<5.0	<1.0	<1.0	<1.0	<0.50	<1.0	<0.50	<0.50	<0.50	<0.50
Bromomethane (Methly bromide)	µg/L	<4.0	<0.80	<0.80	<0.80	4.6(tr)*	<0.80	<0.40	<0.40	<0.40	<0.40
2-Butanone (MEK)	µg/L	<50	<10	<10	<10	<5.0	<10	<5.0	<5.0	<5.0	<5.0
n-Butylbenzene	µg/L	<6.0	<1.2	<1.2	<1.2	<0.60	NA	<0.60	<0.60	<0.60	<0.60

sec-Butylbenzene	µg/L	<6.0	<1.2	<1.2	<1.2	<0.60	NA	<0.60	<0.60	<0.60	<0.60
tert-Butylbenzene	µg/L	<7.0	<1.4	<1.4	<1.4	<0.70	NA	<0.70	<0.70	<0.70	<0.70
Carbon Disulfide	µg/L	<50	<10	<10	<10	<5.0	<10	<5.0	<5.0	<5.0	<5.0
Carbon Tetrachloride	µg/L	<7.5	<1.5	<1.5	<1.5	<0.75	<1.5	<0.75	<0.75	<0.75	<0.75
Chlorobenzene	µg/L	<6.0	<1.2	<1.2	<1.2	<0.60	<1.2	<0.60	<0.60	<0.60	<0.60
Chloroethane	µg/L	<17	<3.4	<3.4	<3.4	<1.7	<3.4	3.1 (tr)	<1.7	2.8 (tr)	5.6
Chloroform	µg/L	<6.0	<1.2	<1.2	<1.2	<0.60	<1.2	<0.60	<0.60	<0.60	<0.60
Chloromethane (Methyl chloride)	µg/L	<12	<2.5	<2.5	<2.5	<1.2	<2.5	<1.2	<1.2	<1.2	<1.2
2-Chlorotoluene	µg/L	<13	<2.6	<2.6	<2.6	<1.3	NA	<1.3	<1.3	<1.3	<1.3
4-Chlorotoluene	µg/L	<5.0	<1.0	<1.0	<1.0	<0.50	NA	<0.50	<0.50	<0.50	<0.50
Dibromochloromethane	µg/L	<20	<4.0	<4.0	<4.0	<2.0	<4.0	<2.0	<2.0	<2.0	<2.0
1,2-Dibromo-3-chloropropane (DBCP)	µg/L	<48	<9.5	<9.5	<9.5	<4.8	<9.5	<4.8	<4.8	<4.8	<4.8
1,2-Dibromoethane (EDB)	µg/L	<11	<2.2	<2.2	<2.2	<1.1	<2.2	<1.1	<1.1	<1.1	<1.1
Dibromomethane (Methly bromide)	µg/L	<10	<2.1	<2.1	<2.1	<1.0	<2.1	<1.0	<1.0	<1.0	<1.0
1,2-Dichlorobenzene	µg/L	<7.0	<1.4	<1.4	<1.4	<0.70	<1.4	<0.70	<0.70	<0.70	<0.70
1,3-Dichlorobenzene	µg/L	<5.5	<1.1	<1.1	<1.1	<0.55	NA	<0.55	<0.55	<0.55	<0.55
1,4-Dichlorobenzene	µg/L	<6.5	<1.3	<1.3	<1.3	<0.65	<1.3	<0.65	<0.65	<0.65	<0.65
trans-1,4-Dichloro-2-butene	µg/L	<50	<10	<10	<10	<5.0	<10	<5.0	<5.0	<5.0	<5.0
Dichlorodifluoromethane (Freon 12)	µg/L	<8.0	2.4(tr)	4.2(tr)	<1.6	16	NA	<0.80	<0.80	<0.80	<0.80
1,1-Dichloroethane (1,1-DCA)	µg/L	<5.0	4.6(tr)	7.4(tr)	9.5(tr)	12	13	1.5 (tr)	2.9 (tr)	3.0 (tr)	9.0
1,2-Dichloroethane (1,2-DCA)	µg/L	<11	2.5(tr)	3.5(tr)	4.0 (tr)	4.8(tr)	5.8(tr)	4.0 (tr)	5.5	5.9	5.4
1,1-Dichloroethene (1,1-DCE)	ug/L	<18	<3.6	<3.6	<3.6	<1.8	<3.6	<1.8	<1.8	<1.8	<1.8
cis-1,2-Dichloroethene (cis-1,2-DCE)	µg/L	<5.0	2.3(tr)	1.9(tr)	<1.0	3.3(tr)	3.5(tr)	3.7 (tr)	2.5 (tr)	2.6 (tr)	1.9 (tr)
trans-1,2-Dichloroethene (trans-1,2-DCE)	µg/L	<5.5	<1.1	<1.1	<1.1	<0.55	<1.1	<0.55	<0.55	<0.55	<0.55
1,2-Dichloropropane	µg/L	<7.5	<1.5	<1.5	<1.5	<0.75	<1.5	<0.75	<0.75	<0.75	<0.75
1,3-Dichloropropane	µg/L	<10	<2.0	<2.0	<2.0	<1.0	NA	<1.0	<1.0	<1.0	<1.0
2,2 Dichloropropane	µg/L	<6.5	<1.3	<1.3	<1.3	<0.65	NA	<0.65	<0.65	<0.65	<0.65
1,1-Dichloropropene	µg/L	<7.0	<1.4	<1.4	<1.4	<0.70	NA	<0.70	<0.70	<0.70	<0.70
cis-1,3-Dichloropropene	µg/L	<11	<2.2	<2.2	<2.2	<1.1	<2.2	<1.1	<1.1	<1.1	<1.1
trans-1,3-Dichloropropene	µg/L	<15	<3.0	<3.0	<3.0	<1.5	<3.0	<1.5	<1.5	<1.5	<1.5
Ethylbenzene	µg/L	<14	<2.7	<2.7	<2.7	<1.4	<2.7	1.4 (tr)	1.4 (tr)	1.5 (tr)	2.2 (tr)
Hexachlorobutadiene	µg/L	<11	<2.2	<2.2	<2.2	<1.1	NA	<1.1	<1.1	<1.1	<1.1
2-Hexanone (Methyl butyl ketone)	µg/L	<50	<10	<10	<10	<5.0	<10	<5.0	<5.0	<5.0	<5.0
Iodomethane (Methyl iodide)	µg/L	<50	<10	<10	<10	<5.0	<10	<5.0	<5.0	<5.0	<5.0

Isopropylbenzene	µg/L	<6.0	<1.2	<1.2	<1.2	<0.60	NA	<0.60	<0.60	<0.60	<0.60
p-Isopropyltoluene	µg/L	<6.5	<1.3	<1.3	<1.3	<0.65	NA	<0.65	<0.65	<0.65	<0.65
Methyl-tert-butyl ether (MTBE)	µg/L	210	190	160	160	180	170	110	90	130	120
4-Methyl-2-pentanone (MIBK)	µg/L	1200	19(tr)	52	<10	<5.0	26	7.1 (tr)	7.7 (tr)	<5.0	<5.0
Methylene Chloride	µg/L	<18	<3.5	<3.5	<3.5	2.1(tr)	<3.5	<1.8	<1.8	2.3 (tr)	<1.8
Naphthalene	µg/L	<7.5	<1.5	<1.5	<1.5	<0.75	NA	<0.75	<0.75	<0.75	<0.75
n-Propylbenzene	µg/L	<7.5	<1.5	<1.5	<1.5	<0.75	NA	<0.75	<0.75	<0.75	<0.75
Styrene	µg/L	<7.5	<1.5	<1.5	<1.5	<0.75	<1.5	<0.75	<0.75	<0.75	<0.75
1,1,1,2-Tetrachloroethane	µg/L	<5.0	<1.0	<1.0	<1.0	<0.50	<1.0	<0.50	<0.50	<0.50	<0.50
1,1,2,2-Tetrachloroethane	µg/L	<18	<3.7	<3.7	<3.7	<1.8	<3.7	<1.8	<1.8	<1.8	<1.8
Tetrachloroethene (PCE)	µg/L	<19	<3.8	<3.8	<3.8	<1.9	NA	<1.9	<1.9	<1.9	<1.9
Toluene	µg/L	150*	42	20	22	22	20	14	7.6	6.6	7.1
1,2,3-Trichlorobenzene	µg/L	<7.0	<1.4	<1.4	<1.4	<0.70	NA	<0.70	<0.70	<0.70	<0.70
1,2,4-Trichlorobenzene	µg/L	<12	<2.3	<2.3	<2.3	<1.2	NA	<1.2	<1.2	<1.2	<1.2
1,1,1-Trichloroethane (1,1,1-TCA)	µg/L	<20	<4.1	<4.1	<4.1	<2.0	<4.1	<2.0	<2.0	<2.0	<2.0
1,1,2-Trichloroethane (1,1,2-TCA)	µg/L	<16	<3.1	<3.1	<3.1	<1.6	<3.1	<1.6	<1.6	<1.6	<1.6
Trichloroethene (TCE)	µg/L	<16	<3.1	<3.1	<3.1	<1.6	<3.1	<1.6	<1.6	<1.6	<1.6
Trichlorofluoromethane (Freon 11)	µg/L	<12	<2.3	2.7(tr)	<2.3	<1.2	<2.3	<1.2	<1.2	<1.2	<1.2
1,2,3-Trichloropropane	µg/L	<15	<3.0	<3.0	<3.0	<1.5	<3.0	<1.5	<1.5	<1.5	<1.5
1,2,4-Trimethylbenzene	µg/L	<6.0	<1.2	<1.2	<1.2	<0.60	NA	<0.60	<0.60	<0.60	<0.60
1,3,5-Trimethylbenzene	µg/L	<7.0	<1.4	<1.4	<1.4	<0.70	NA	<0.70	<0.70	<0.70	<0.70
Vinyl Acetate	µg/L	<50	<10	<10	<10	<5.0	<10	<5.0	<5.0	<5.0	<5.0
Vinyl Chloride	µg/L	<6.0	<1.2	<1.2	<1.2	<0.60	<1.2	2.3 (tr)	<0.60	3.3 (tr)	10
Total Xylenes	µg/L	<5.0	4.0(tr)	3.8(tr)	<1.0	3.4(tr)	4.0(tr)	2.8 (tr)	2.1 (tr)	2.4 (tr)	4.8 (tr)

Footnotes:

NA=Not Analyzed

MDL=Method Detection Limit

PQL=Practical Quantification Limit

<=Less than the MDL

tr=trace: the amount detected was above the MDL but below the PQL

* = this parameter was alo detected in the method blank

Table 5-7. Analytical Results for Leachate Sampled form the Aerobic Cell Manhole

PARAMETER	DATE:	2/26/2002	3/27/2002	5/14/2002	5/29/2003
Field Parameters:	**Units**				
pH		7.75	8.17	8.48	8.48
Electrical Conductivity	µS	7026	7705	9048	9426
Oxidation Reduction Potential	mV	195	195	127	201
Temperature	C	15.1	15.2	21.1	27.9
Dissolved Oxygen	mg/L	5.45	5.73	6.8	1.67
Total Dissolved Solids	ppm	5673	NA	7448	7686
General Chemistry:					
Bicarbonate Alkalinity	mg/L	1120	935	1020	1480
Carbonate Alkalinity	mg/L	NA	<5.0	24.8	34.6
Total Alkalinity as CO_3	mg/L	1120	935	1050	1510
BOD	mg O/L	3.3	5	89	35
Chemical Oxygen Demand	mg O/L	595	563	602	818
Chloride	mg/L	1610	1800	2290	1740
Hydroxide	mg/L	<5.0	<5.0	<5.0	<5.0
Ammonia as N	mg/L	2.8	1.1	0.60(tr)	36
Nitrate-Nitrite as N	mg/L	0.16	0.22	4.8(tr)	4.8
Total Kjeldahl Nitrogen	mg/L	19.9	19.2	11.1	69.1
Sulfate	mg/L	290	478	526	544
Total Dissolved Solids @ 180 C	mg/L	4810	5200	5640	6330
Total (Non-Volatile) Organic Carbon	mg/L	766	149	168	215
Total Phosphorus	mg/L	0.51	0.19	0.85*	1.2
Total Sulfide	mg/L	<0.014	0.015(tr)	<0.014	<0.0093
Metals:					
Dissolved Aluminum	mg/L	<0.043	<0.043	0.082(tr)*	<0.043
Dissolved Antimony	mg/L	0.002	0.0016(tr)	0.002	0.0037
Dissolved Arsenic	mg/L	0.012	0.015	0.017	0.027
Dissolved Barium	mg/L	0.43	0.54	1.9	0.54
Dissolved Beryllium	mg/L	<0.000078	<0.000078	<0.000078	<0.00039
Dissolved Boron	mg/L	NA	12.2	3.8	14.3
Dissolved Cadmium	mg/L	0.00013(tr)	0.00016(tr)	0.0062	0.00017 (tr)
Dissolvd Calcium	mg/L	NA	57	257	46
Dissolved Chromium	mg/L	0.01	0.0062	0.0062	0.046
Dissolved Cobalt	mg/L	0.0095	0.0073	0.004	0.014
Dissolved Copper	mg/L	0.016	0.014	0.019	0.0090 (tr)
Dissolved Iron	mg/L	0.32	0.084(tr)	0.34	0.81
Dissolved Lead	mg/L	0.00026(tr)	<0.000066	0.00061(tr)	0.0017
Dissolved Magnesium	mg/L	273	260	220	401
Dissolved Manganese	mg/L	1.1	0.77	23.9	0.29
Dissolved Mercury	mg/L	<0.000049	0.000059	0.000074(tr)	<0.000064
Dissolved Molybdenum	mg/L	0.026(tr)	0.033(tr)	<0.0046	0.024 (tr)
Dissolved Nickel	mg/L	0.14	0.11	0.11	0.12
Dissolved Potassium	mg/L	NA	66.1	47.8	165
Dissolved Phosphorus	mg/L	NA	0.47	<0.312	1.2
Dissolved Selenium	mg/L	<0.0085	0.0034	0.0053	0.0038
Dissolved Silver	mg/L	<0.00003	<0.00003	<0.00003	0.000043 (tr)

Dissolved Sodium	mg/L	NA	1260	284	1430
Dissolved Thallium	mg/L	<0.00034	<0.00034	<0.00034	<0.00034
Dissolved Tin	mg/L	<0.022	<0.022	<0.022	0.042 (tr)
Dissolved Vanadium	mg/L	0.023(tr)	0.018(tr)	<0.0032	0.033 (tr)
Dissolved Zinc	mg/L	0.027*	0.032	0.018	0.057
Volatile Organic Compounds:					
Acetone	µg/L	12	23	8.8	59
Acrylonitrile	µg/L	<10	<10	<10	<10
Benzene	µg/L	0.43(tr)*	0.27(tr)*	0.17(tr)	0.88 (tr)
Bromobenzene	µg/L	<0.18	<0.18	<0.18	<0.18
Bromochloromethane	µg/L	<0.31	<0.31	<0.31	<0.31
Bromodichloromethane	µg/L	<0.14	<0.14	<0.14	<0.14
Bromoform	µg/L	<0.10	<0.10	<0.10	<0.10
Bromomethane (Methly bromide)	µg/L	<0.08	<0.08	0.23(tr)	0.72 (tr)
2-Butanone (MEK)	µg/L	2.5	<1.0	<0.12	5
n-Butylbenzene	µg/L	<0.12	<0.12	<0.12	<0.12
sec-Butylbenzene	µg/L	<0.12	<0.12	<0.12	<0.12
tert-Butylbenzene	µg/L	<0.14	<0.14	<0.14	<0.14
Carbon Disulfide	µg/L	<1.0	<1.0	<1.0	<1.0
Carbon Tetrachloride	µg/L	<0.15	<0.15	<0.15	<0.15
Chlorobenzene	µg/L	2	2.8	0.23(tr)	4.8
Chloroethane	µg/L	<0.34	<0.34	<0.34	<0.34
Chloroform	µg/L	<0.12	<0.12	<0.12	<0.12
Chloromethane (Methyl chloride)	µg/L	<0.25	0.46(tr)	0.33(tr)	3.9
2-Chlorotoluene	µg/L	<0.26	0.31(tr)	<0.26	<0.26
4-Chlorotoluene	µg/L	<0.10	<0.10	<0.10	<0.10
Dibromochloromethane	µg/L	<0.40	<0.40	<0.40	<0.40
1,2-Dibromo-3-chloropropane (DBCP)	µg/L	<0.95	<0.95	<0.95	<0.95
1,2-Dibromoethane (EDB)	µg/L	<0.22	<0.22	<0.22	<0.22
Dibromomethane (Methly bromide)	µg/L	<0.21	<0.21	<0.21	<0.21
1,2-Dichlorobenzene	µg/L	<0.14	<0.14	<0.14	<0.14
1,3-Dichlorobenzene	µg/L	<0.11	<0.11	<0.11	<0.11
1,4-Dichlorobenzene	µg/L	<0.13	<0.13	<0.13	<0.13
trans-1,4-Dichloro-2-butene	µg/L	<1.0	<1.0	<1.0	<1.0
Dichlorodifluoromethane (Freon 12)	µg/L	0.27(tr)	<0.16	<1.0	<0.16
1,1-Dichloroethane (1,1-DCA)	µg/L	0.32(tr)	0.16(tr)	<0.10	<0.10
1,2-Dichloroethane (1,2-DCA)	µg/L	<0.22	<0.22	<0.22	<0.22
1,1-Dichloroethene (1,1-DCE)	µg/L	<0.36	<0.36	<0.36	<0.36
cis-1,2-Dichloroethene (cis-1,2-DCE)	µg/L	0.38(tr)	0.20(tr)	<0.10	<0.10
trans-1,2-Dichloroethene (trans-1,2-DCE)	µg/L	<0.11	<0.11	<0.11	<0.11
1,2-Dichloropropane	µg/L	<0.15	<0.15	<0.15	<0.15
1,3-Dichloropropane	µg/L	<0.20	<0.20	<0.20	<0.20
2,2 Dichloropropane	µg/L	<0.13	<0.13	<0.13	<0.13
1,1-Dichloropropene	µg/L	<0.14	<0.14	<0.14	<0.14
cis-1,3-Dichloropropene	µg/L	0.38(tr)	<0.22	<0.22	<0.22

trans-1,3-Dichloropropene	µg/L	<0.30	<0.30	<0.30	<0.30
Ethylbenzene	µg/L	<0.27	<0.27	<0.27	<0.27
Hexachlorobutadiene	µg/L	<0.22	<0.22	<0.22	<0.22
2-Hexanone (Methyl butyl ketone)	µg/L	<1.0	<1.0	<1.0	<1.0
Iodomethane (Methyl iodide)	µg/L	<1.0	<1.0	<1.0	<1.0
Isopropylbenzene	µg/L	<0.12	<0.12	<0.12	<0.12
p-Isopropyltoluene	µg/L	<0.13	<0.13	<0.13	<0.13
Methyl-tert-butyl ether (MTBE)	µg/L	3	<1.0	1.3(tr)	<1.0
4-Methyl-2-pentanone (MIBK)	µg/L	3.8	<1.0	3.3	1.7 (tr)
Methylene Chloride	µg/L	0.35(tr)	<0.35	<0.35	<0.35
Naphthalene	µg/L	<0.15	<0.15	<0.15	<0.15
n-Propylbenzene	µg/L	<0.15	<0.15	<0.15	<0.15
Styrene	µg/L	<0.15	<0.15	<0.15	<0.15
1,1,1,2-Tetrachloroethane	µg/L	<0.10	<0.10	<0.10	<0.10
1,1,2,2-Tetrachloroethane	µg/L	<0.37	<0.37	<0.37	<0.37
Tetrachloroethene (PCE)	µg/L	0.67(tr)	0.60(tr)	0.88(tr)	<0.38
Toluene	µg/L	0.35(tr)	0.27(tr)*	<0.25	<0.25
1,2,3-Trichlorobenzene	µg/L	<0.14	<0.14	<0.14	<0.14
1,2,4-Trichlorobenzene	µg/L	<0.23	<0.23	<0.23	<0.23
1,1,1-Trichloroethane (1,1,1-TCA)	µg/L	<0.41	<0.41	<0.41	<0.41
1,1,2-Trichloroethane (1,1,2-TCA)	µg/L	<0.31	<0.31	<0.31	<0.31
Trichloroethene (TCE)	µg/L	1.6	0.83(tr)	<0.31	<0.31
Trichlorofluoromethane (Freon 11)	µg/L	<0.23	<0.23	<0.23	<0.23
1,2,3-Trichloropropane	µg/L	<0.30	<0.30	<0.30	<0.30
1,2,4-Trimethylbenzene	µg/L	<0.12	<0.12	<0.12	<0.12
1,3,5-Trimethylbenzene	µg/L	<0.14	<0.14	<0.14	<0.14
Vinyl Acetate	µg/L	<1.0	<1.0	<1.0	<1.0
Vinyl Chloride	µg/L	<0.12	<0.12	<0.12	<0.12
Total Xylenes	µg/L	0.34(tr)	0.10(tr)	<0.10	1.2

Footnotes:
NA=Not Analyzed
MDL=Method Detection Limit
PQL=Practical Quantification Limit
<=Less than the MDL
tr=trace: the amount detected was above the MDL but below the PQL
* = this parameter was alo detected in the method blank