APPLIED RESEARCH: WILLIAMSON COUNTY AERATED BIOREACTOR LANDFILL

Presented by

Civil & Environmental Consultants

for the

Intercontinental Landfill Research Symposium

Asheville, NC

PROJECT TEAM

Williamson County, Tennessee Government

Civil & Environmental Consultants, Inc.

Tennessee Technological University

University of Georgia

Environmental Control Systems, Inc.

WILLIAMSON COUNTY DEPARTMENT OF SOLID WASTE MANAGEMENT

- **Department is managed by Mr. Lewis Bumpus, former county-assistance consultant for the University of Tennessee on solid waste management issues**
- **100% funding for the bioreactor research is provided by Williamson County government**
- **Bioreactor research site is currently operated and maintained by Williamson County and CEC personnel**

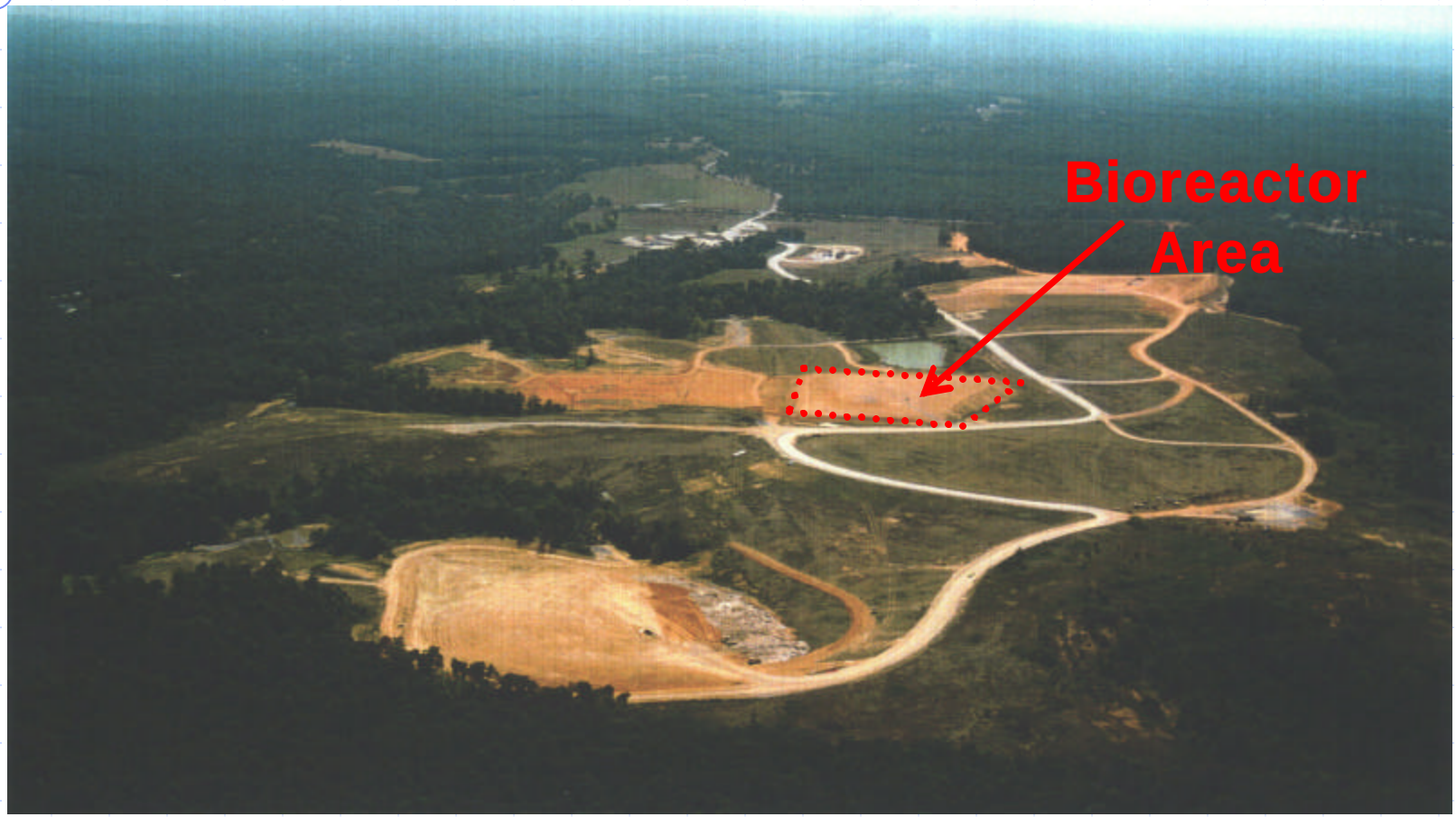
OTHER PROJECT TEAM MEMBERS

- **Tennessee Tech Department of Civil and Environmental Engineering and the University of Georgia Bioconversion Research and Education Center are involved in providing services for solids processing and analysis**

- **Environmental Control Systems provided the original design and installation services for the air and leachate delivery system (vertical injection wells and header pipes, pumps, blowers, thermocouples)**

- **ALL FIELD AND REMOTE DATA FOR THIS PROJECT HAS BEEN COLLECTED BY CEC. ALL STATISTICAL ANALYSES AND DATA INTERPRETATION HAS BEEN PERFORMED BY CEC.**

WILLIAMSON COUNTY LANDFILL



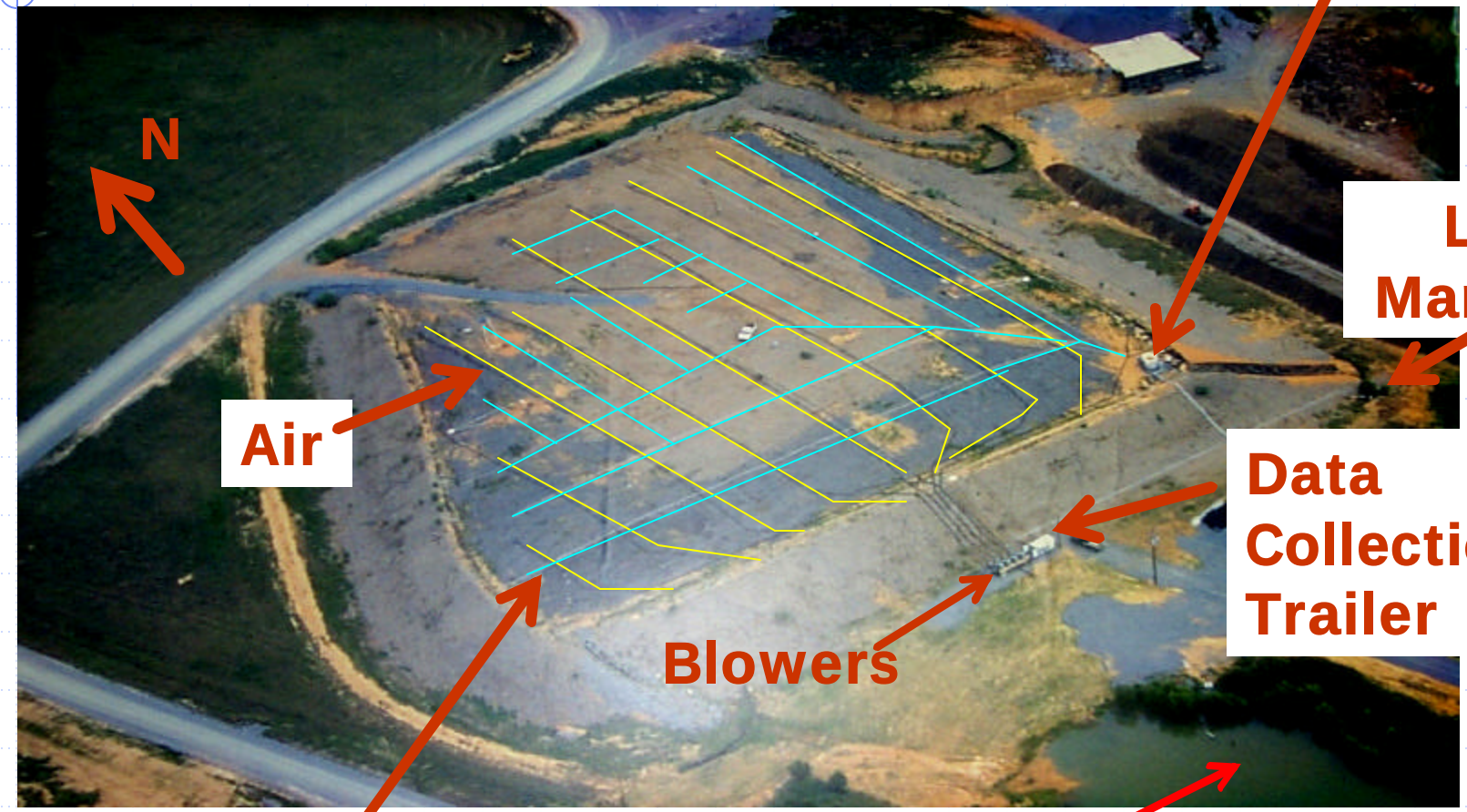
WILLIAMSON COUNTY BIOREACTOR FACT SHEET

- **Waste footprint = 6 acres (2.43 hectares) at base**
- **Maximum waste depth is approximately 40 feet (12.2 meters)**
- **Total original waste tonnage = 69,880 short tons or 63,394 Mg (currently closed; received wastes from 1995 to 1998; – stopped receiving MSW in early 1998)**
- **Shape of subject area resembles a truncated pyramid with steep sideslopes (Avg 1.5:1)**
- **Retrofit operation only. No pre-processing of wastes occurred before placement. No new waste placement is taking place.**

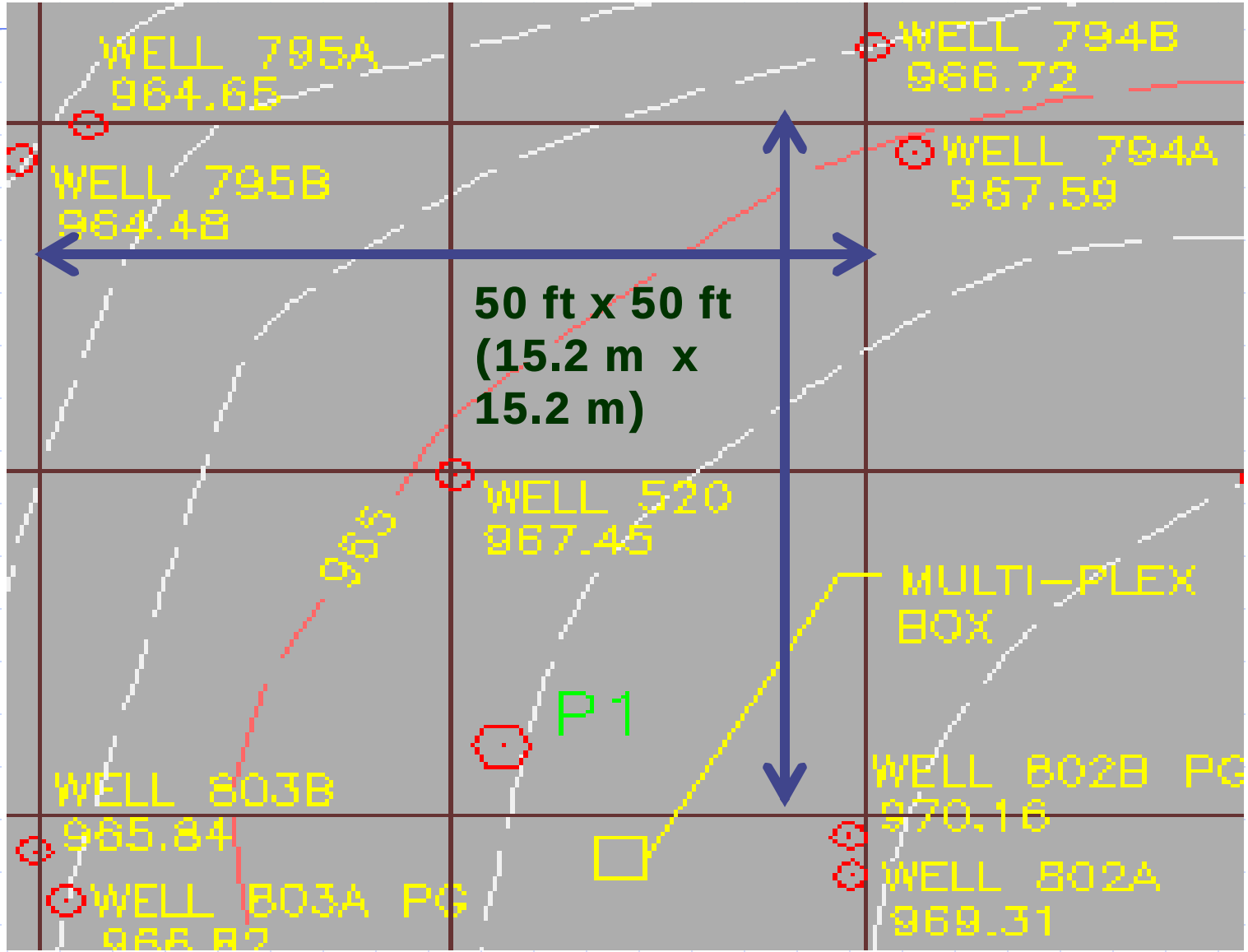
WILLIAMSON COUNTY BIOREACTOR FACT SHEET

- **Site has been operating continuously as a forced-aeration bioreactor landfill since October 17, 2000**
- **Compressed air is injected into the waste via vertical screened wells. Three 1000 acfm (28.3 m^3/min) blowers are utilized on-site**
- **Leachate, and occasionally storm water, is pumped into the mass via vertical screened wells**
- **This is a "temperature-feedback" operation. Subsurface temperatures are monitored by over approximately 170 type "T" thermocouple locations within the waste mass**

SYSTEM LAYOUT



TYPICAL VERTICAL INJECTION WELL ARRANGEMENT



INJECTION PIPE GRID

POSITIVE DISPLACEMENT BLOWERS

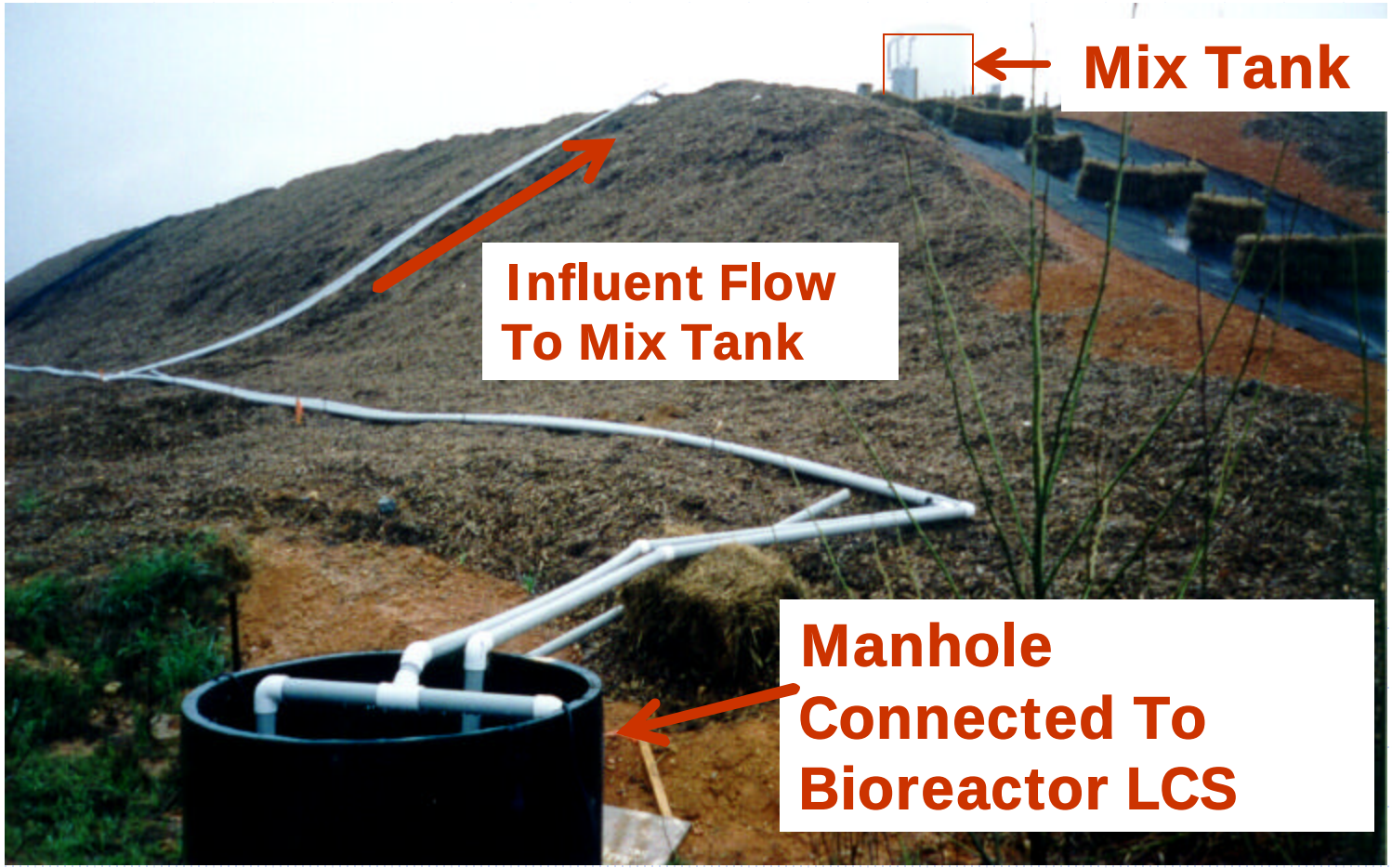
AIR HEADER SYSTEM BACKPRESSURE MONITORING

CLUSTER WELLS

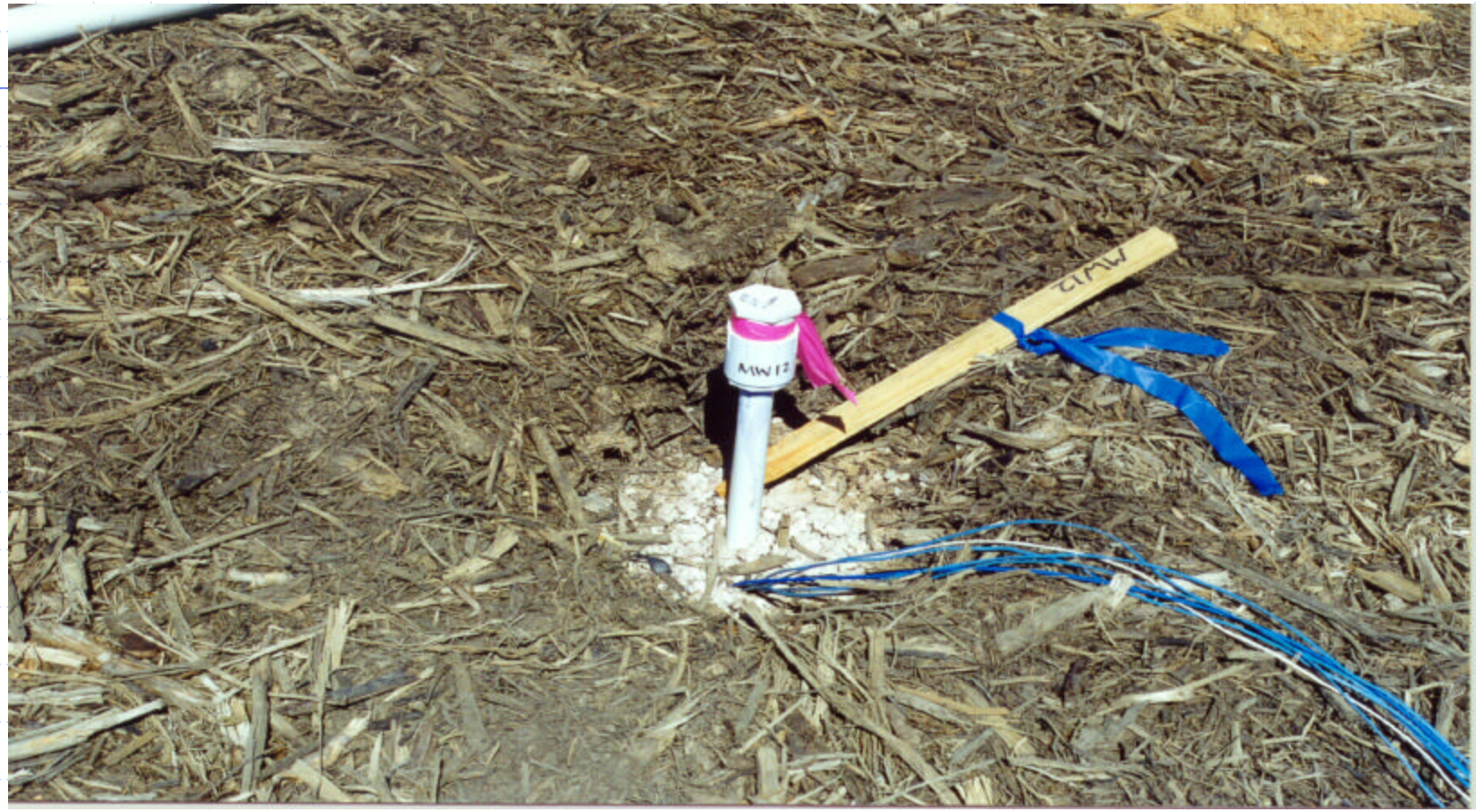
WILLIAMSON COUNTY BIOREACTOR FACT SHEET (CONTINUED)

- The site is composite lined with a granular-material underdrain leachate collection system. All leachate flow drains towards the southeast corner of the footprint
- Injected volume of leachate/storm water to date is approximately 4.3 million gallons (16.3 million liters)
- Leachate injection rate has varied from 0.01 to 0.07 gallon/cy waste/day (0.05 to 0.35 liters/m^3 waste/day)
- Maximum head on the liner to date has not exceeded 4 inches (10 cm) per data collected from risers

MIX TANK AND LCS MANHOLE

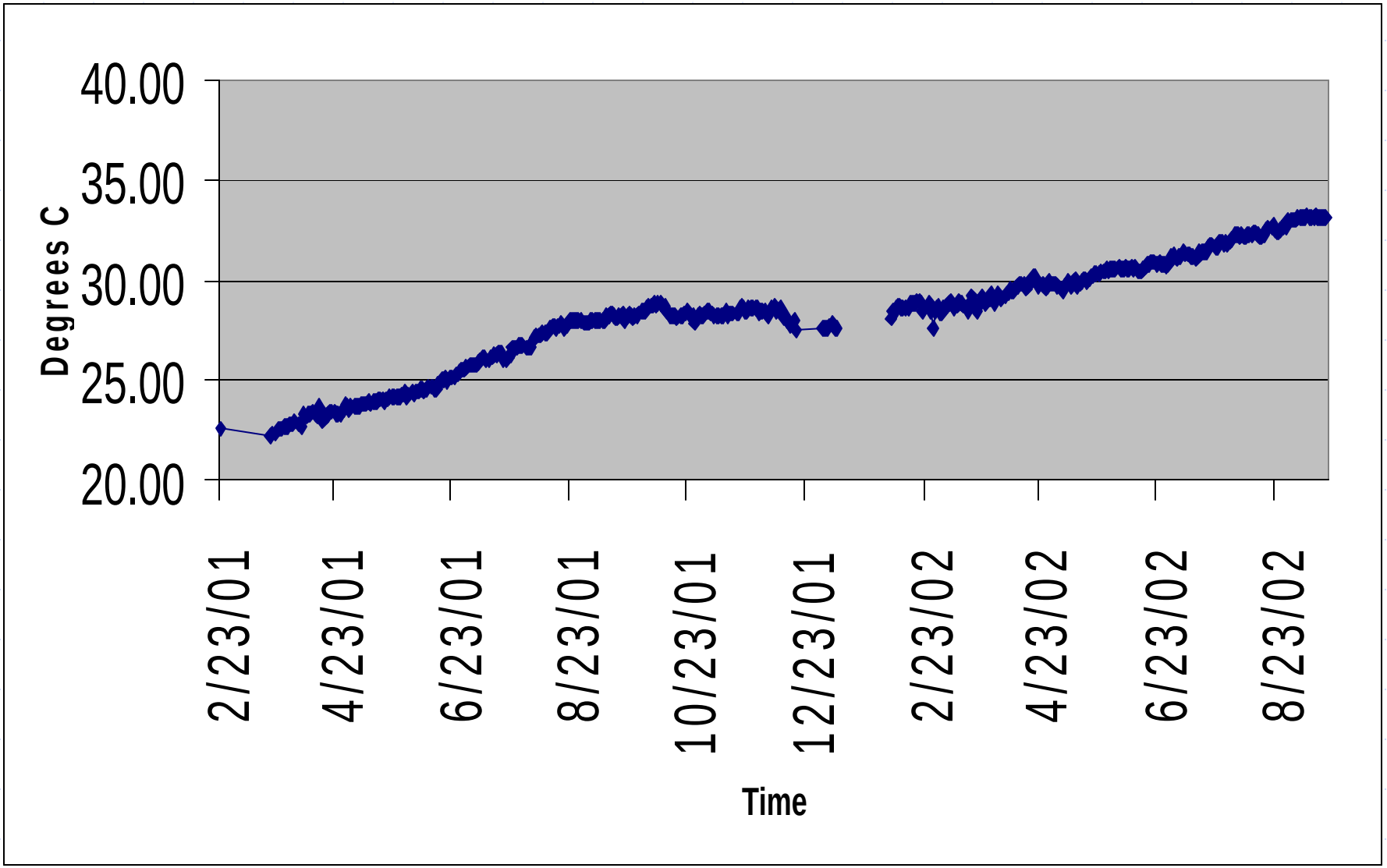


MONITORING WELLS



There are a total of 11 monitoring wells randomly dispersed throughout the footprint of the bioreactor. The wells are used for gas and leachate sampling/analysis. Temperatures are logged at various depth intervals at each monitoring well.

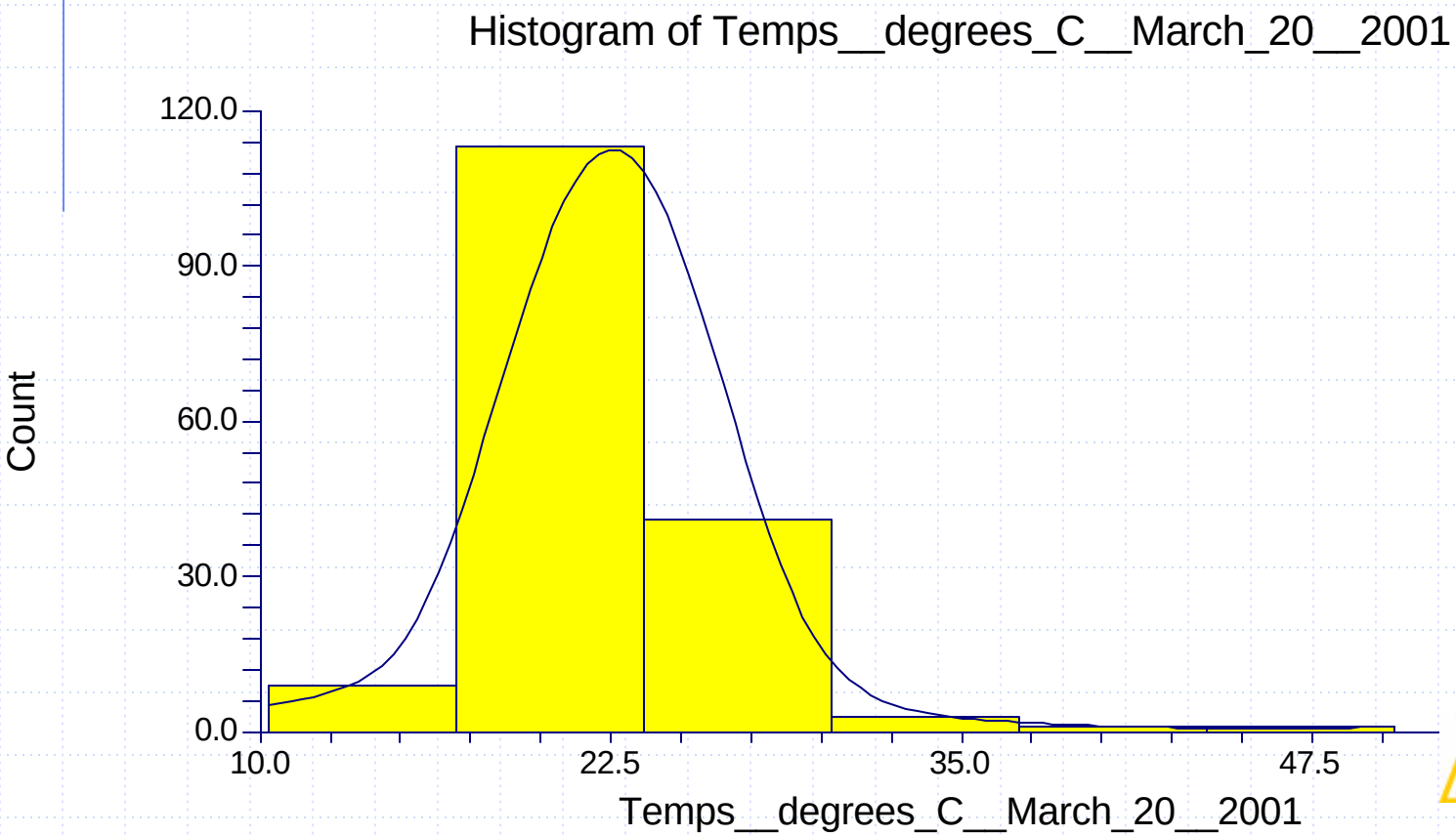
SUBSURFACE TEMPERATURE HISTORY



AVERAGE TEMPERATURE DISTRIBUTION OVER ALL DEPTHS (MARCH 2001)

Temperature Range: 10.29º to 50.47º C

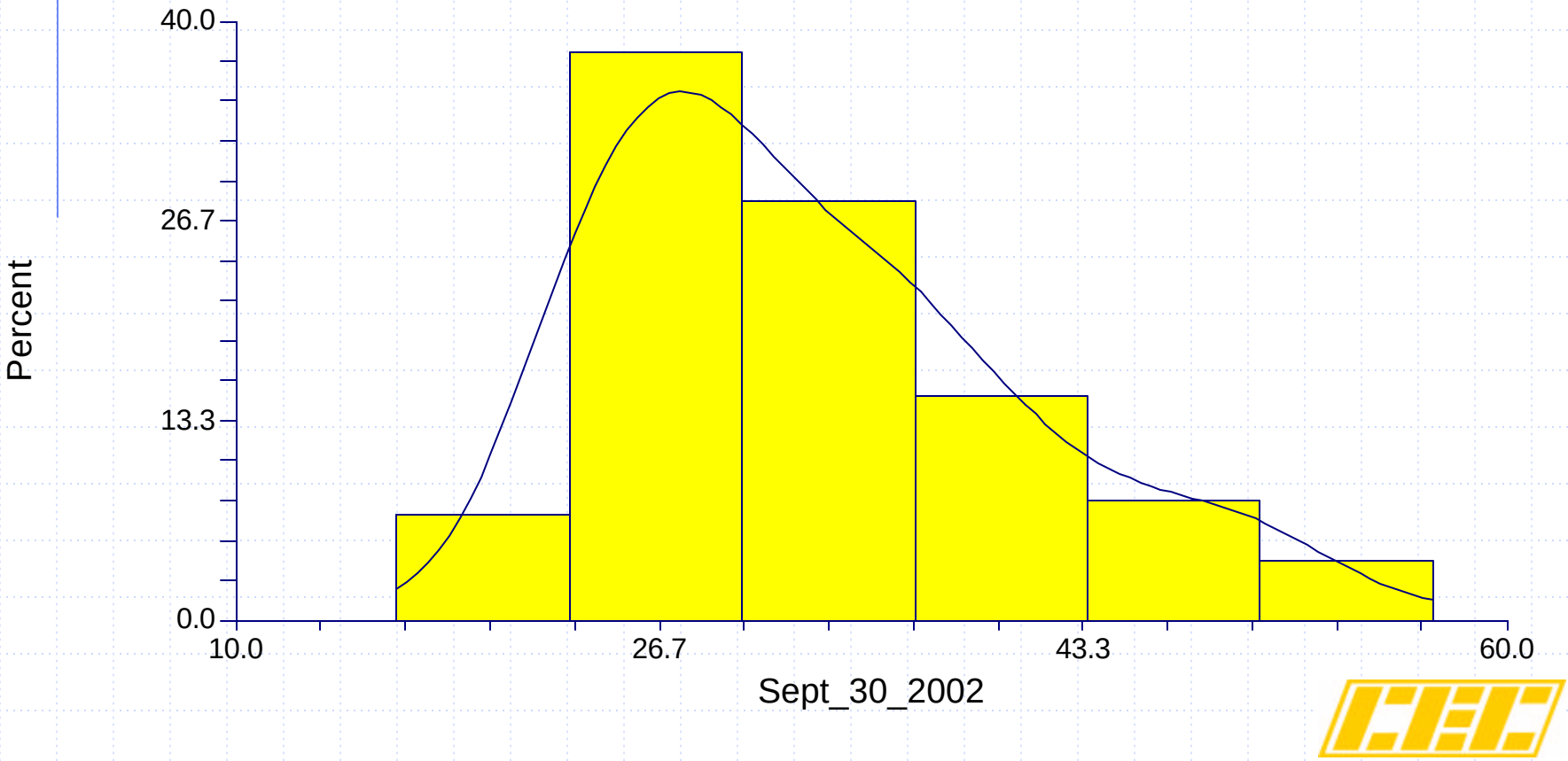
Mean = 22.64 º C



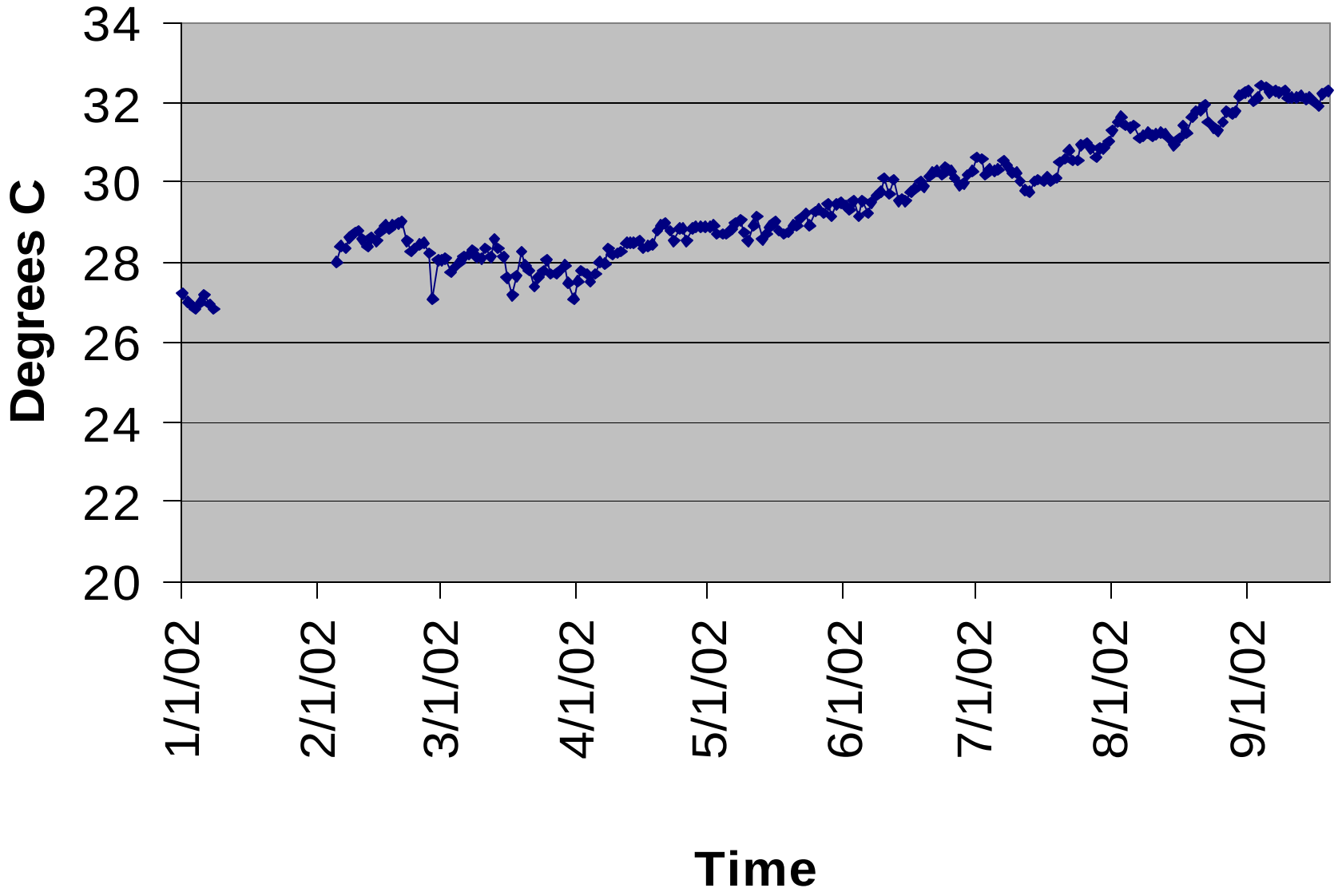
AVERAGE TEMPERATURE DISTRIBUTION OVER ALL DEPTHS (September 30 2002)

Temperature Range: 16.3° to 57° C

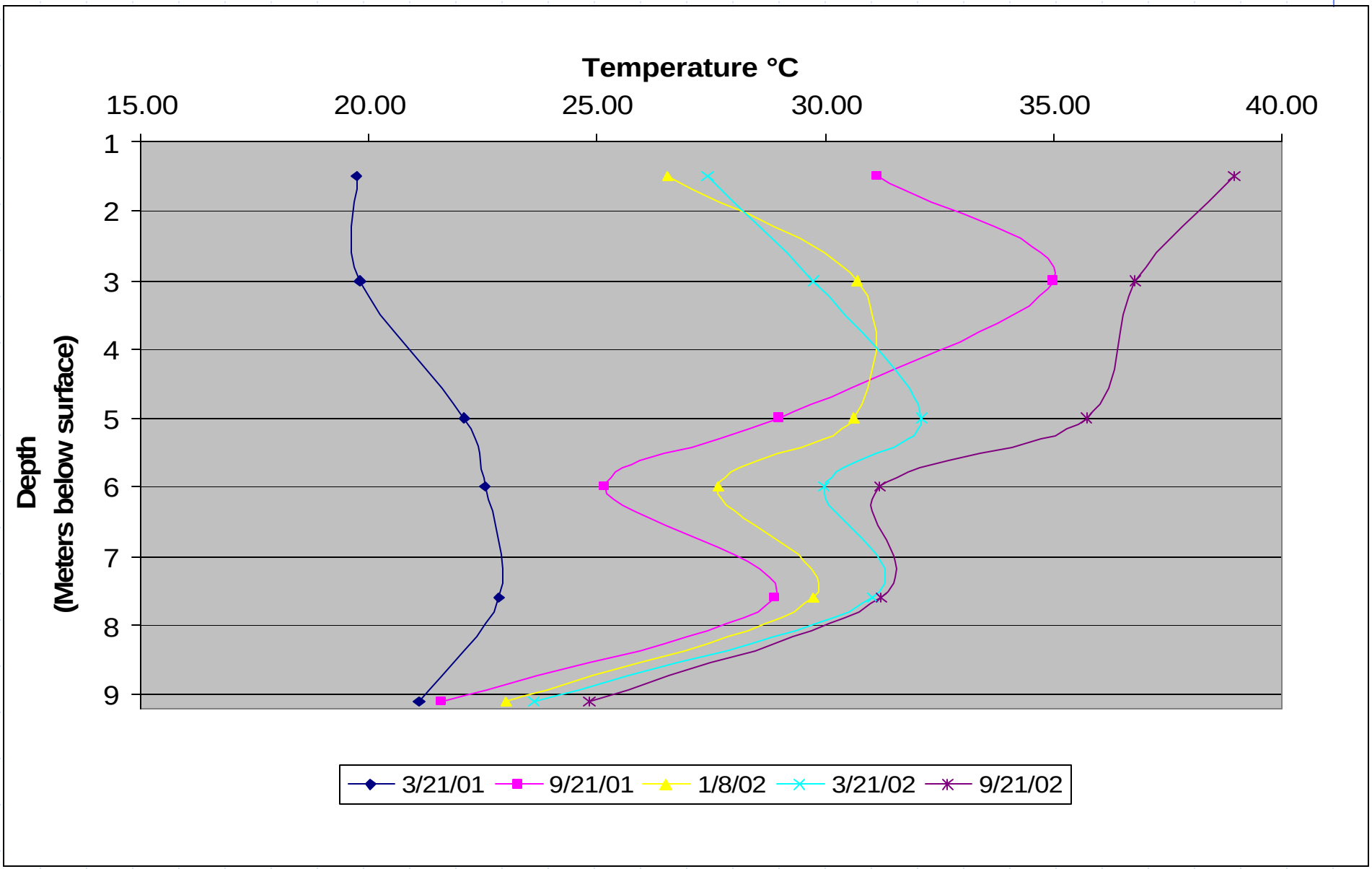
Mean = 40.8° C



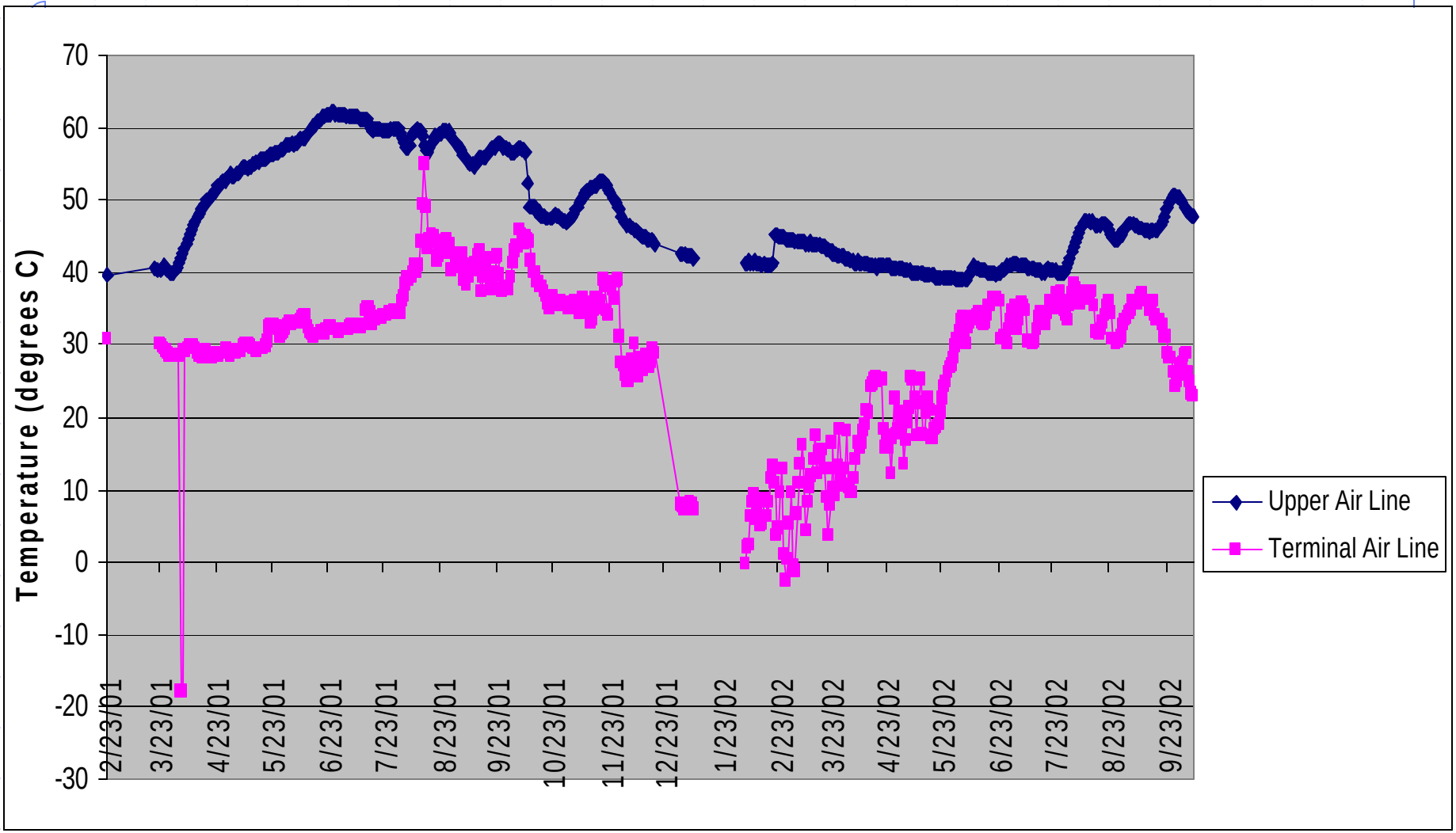
AVERAGE WELL TEMPERATURES FOR 2002 WITHOUT THE EFFECTS FROM AIR INJECTION



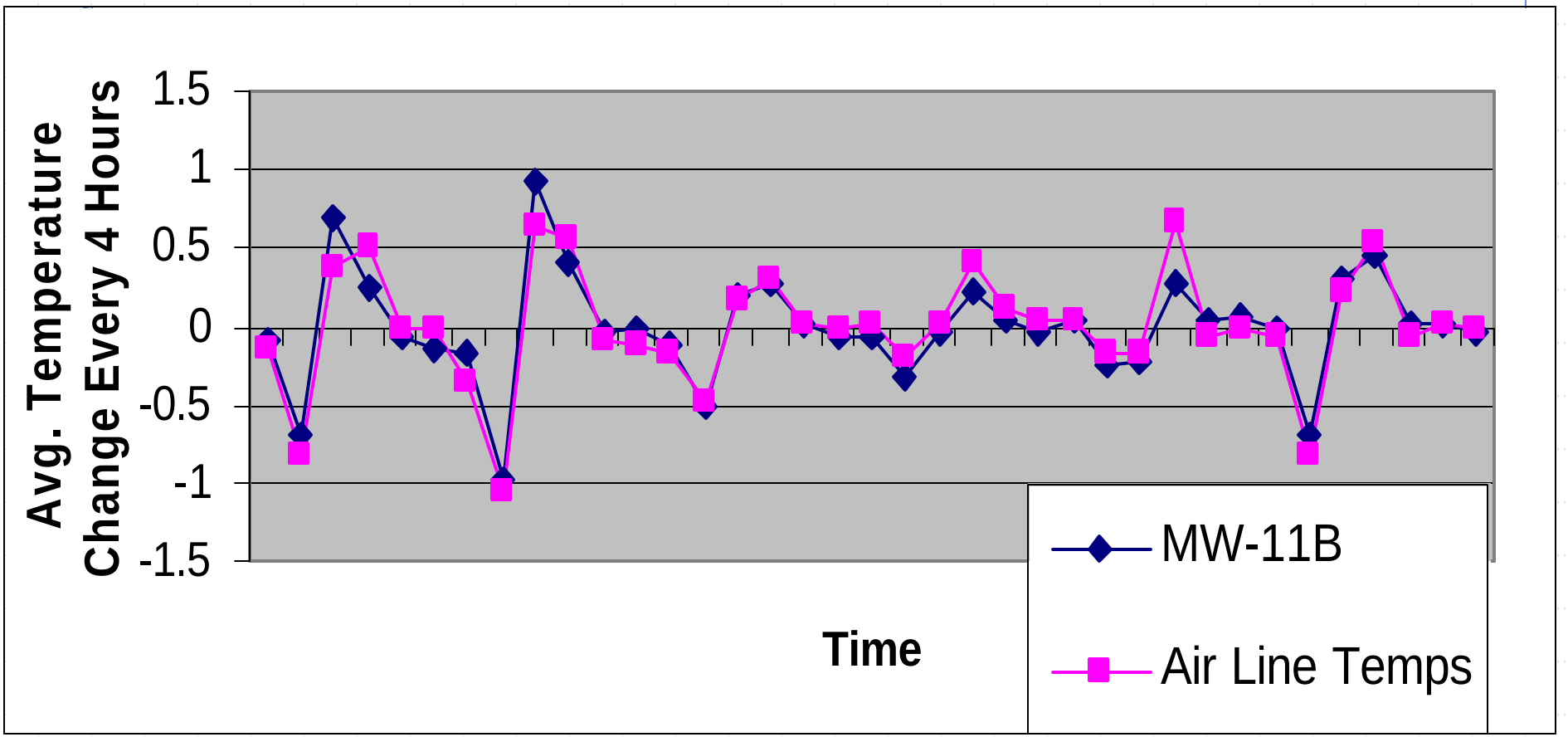
AVERAGE OF ALL MONITORING WELL TEMPERATURES RELATIVE TO DEPTH



INJECTION AIR TEMERATURE VARIATIONS

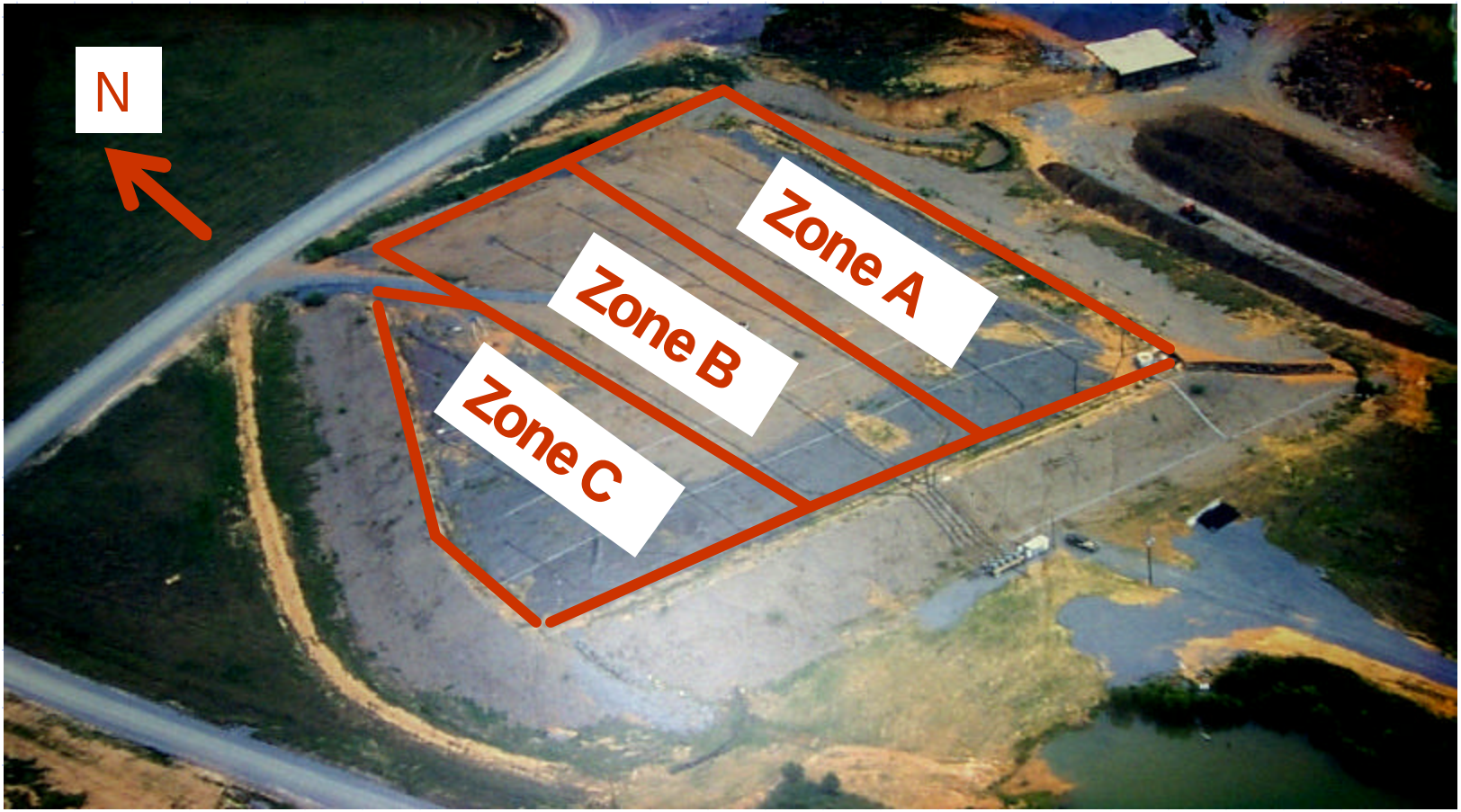


Inlet Air Temperatures vs. MW-11 Temperatures at 5 to 10 ft Depth (1.5 to 3 meters)

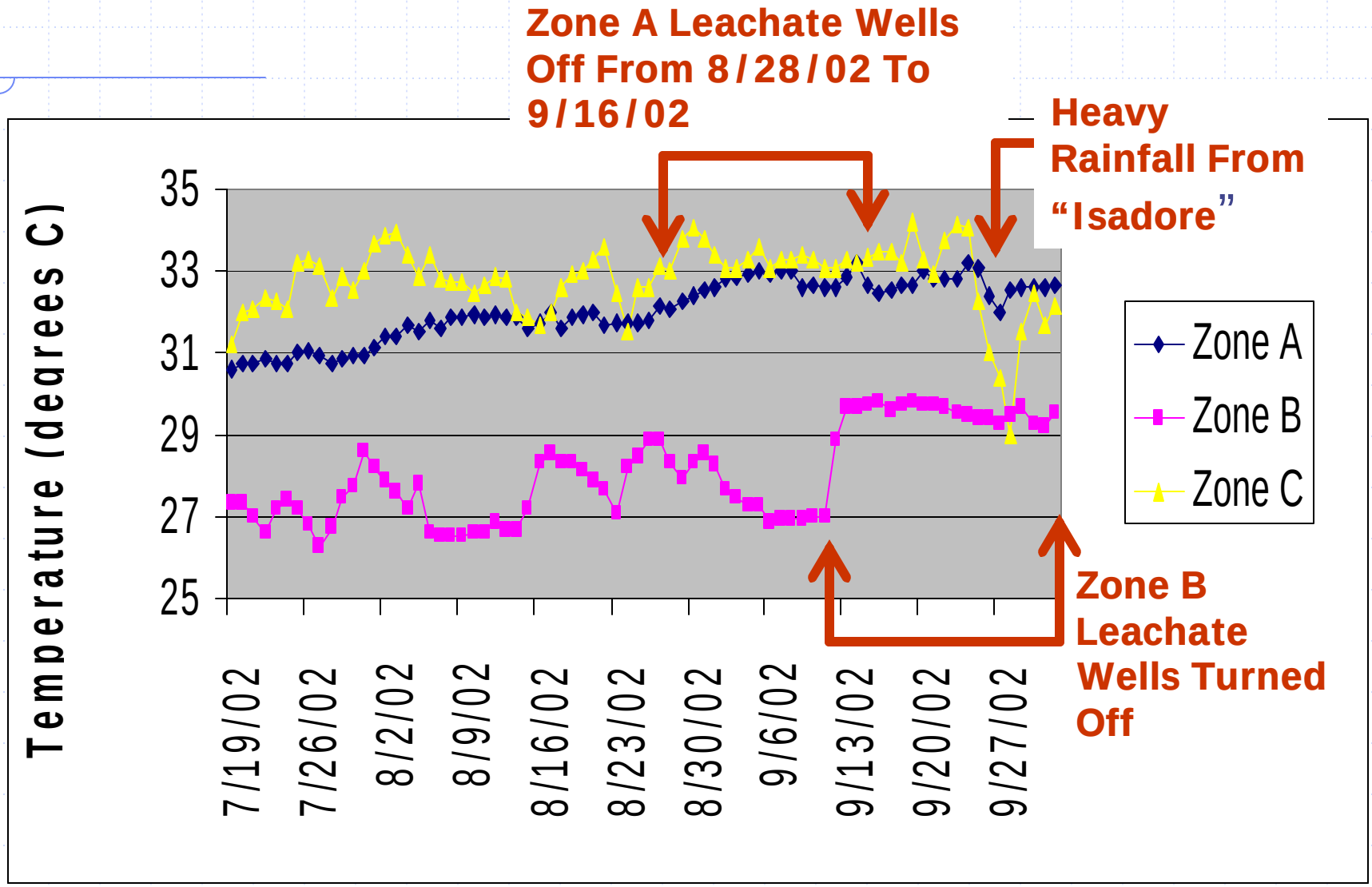


- **Assessing air injection influence on MWs based on comparison of injection air temp changes with internal MW temp changes.**

OPERATIONAL ZONES



OVERALL AVERAGE TEMPERATURES BY ZONE

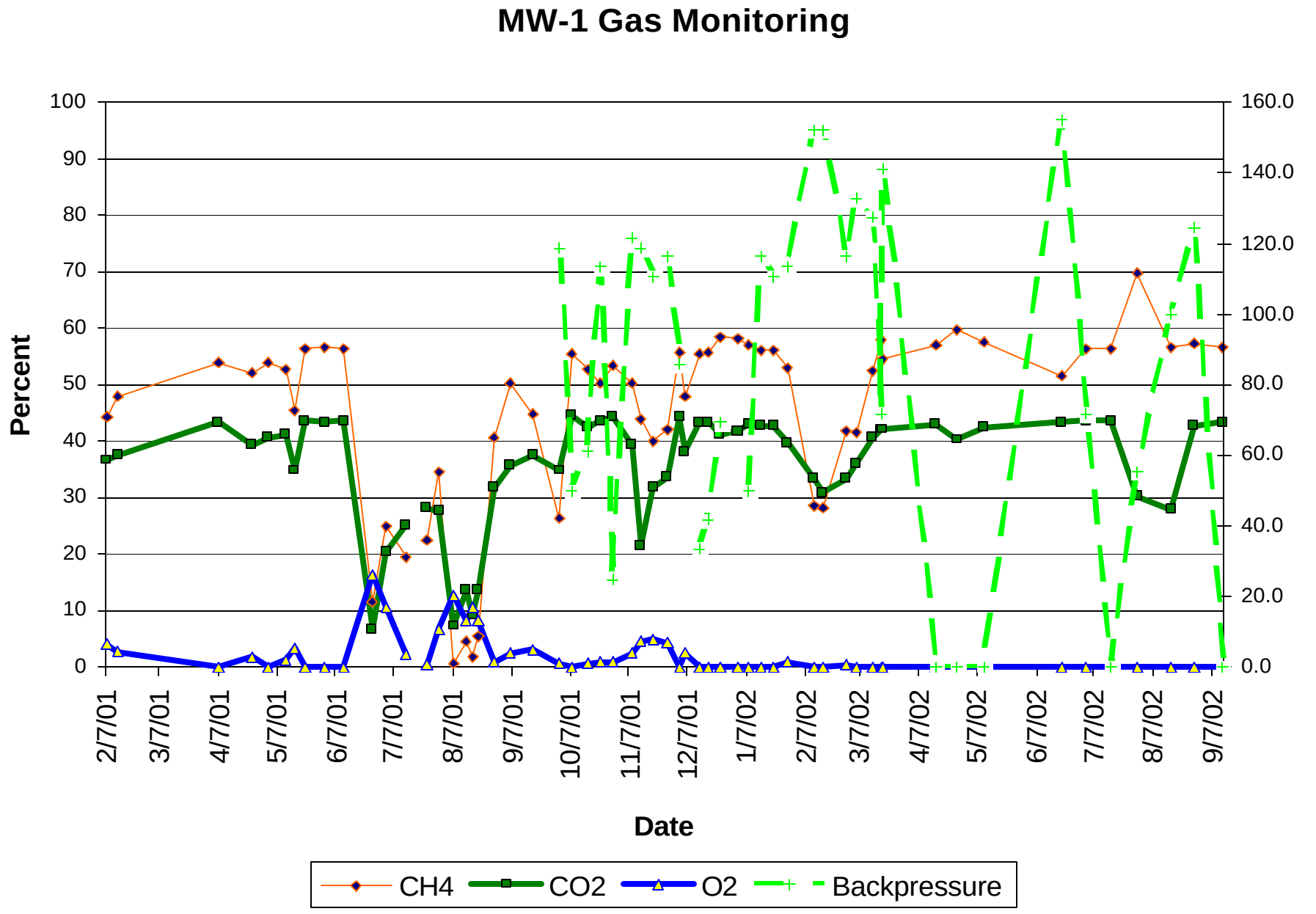


GAS DATA

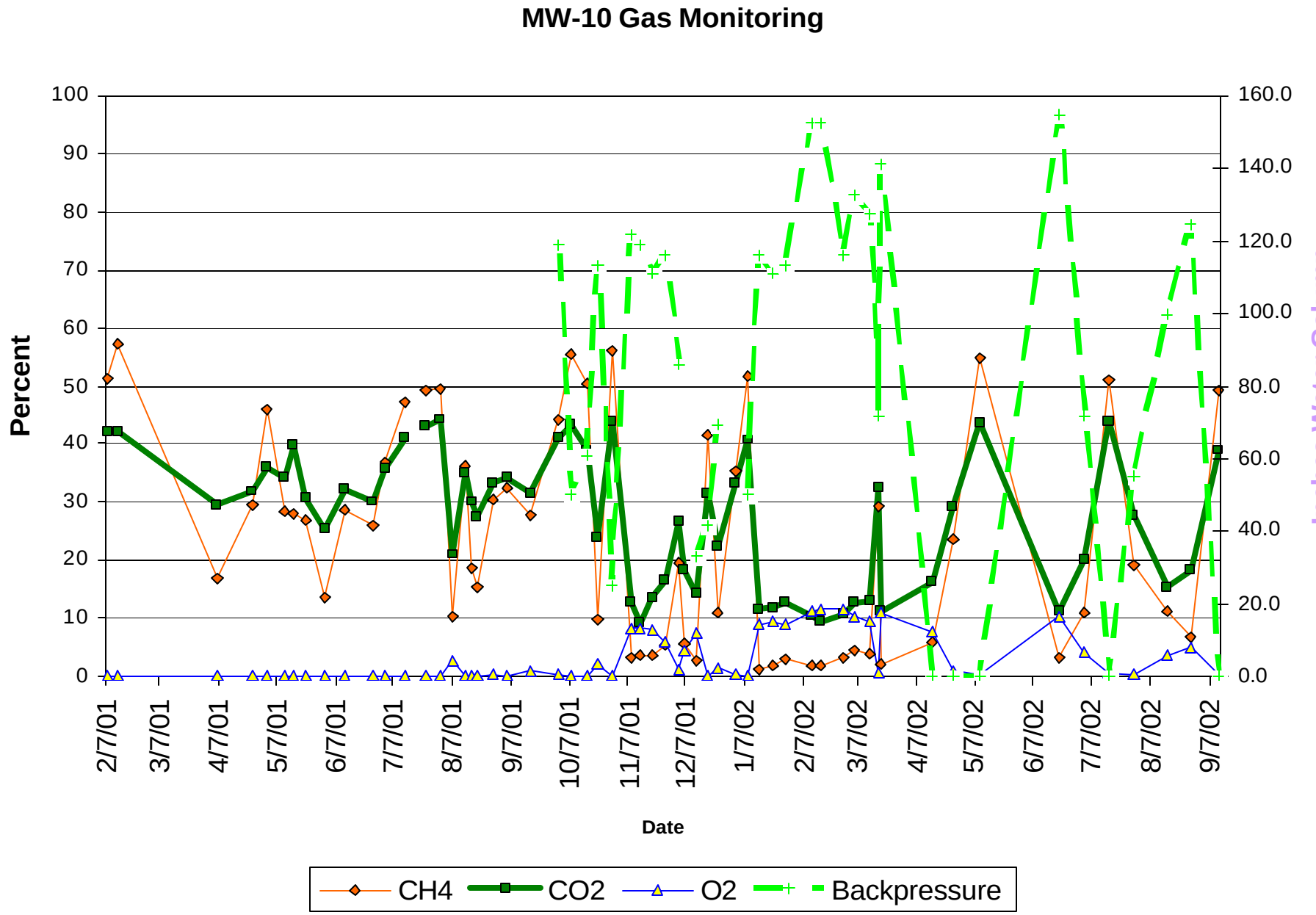
MONITORING WELL WITH GAS CONNECT PORT

LANDTEC GEM 500 GAS ANALYZER

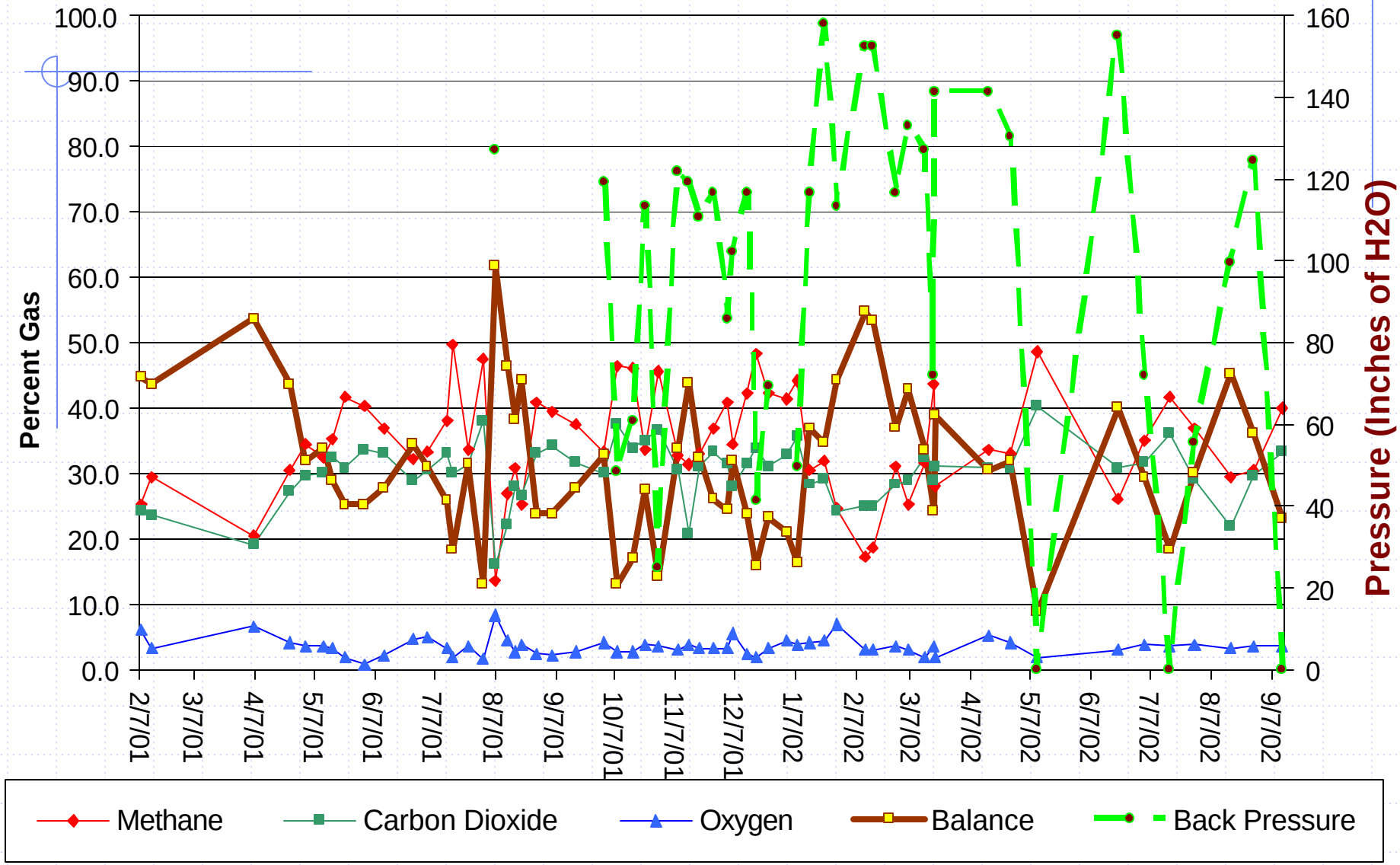
BIOREACTOR GAS EMISSION DATA



BIOREACTOR GAS EMISSION DATA



BIOREACTOR GAS EMISSION DATA - OVERALL AVERAGE FOR ALL MONITORING WELLS COMBINED



QUALITATIVE GAS CHARACTERIZATION

- **Most of the monitoring wells respond to and are influenced by air injection points when air header system static backpressure is greater than 4.5 to 5 psig (best response is when system BP is over 6 psig)**
- **Overall, the gas characterization from each monitoring well has been influenced by the air injection. The degree of influence varies with the spatial location of the MWs.**
- **Typically, the lowered CH_4 values are seen when the air system header has elevated backpressures indicating minimal leakage from the header piping system**

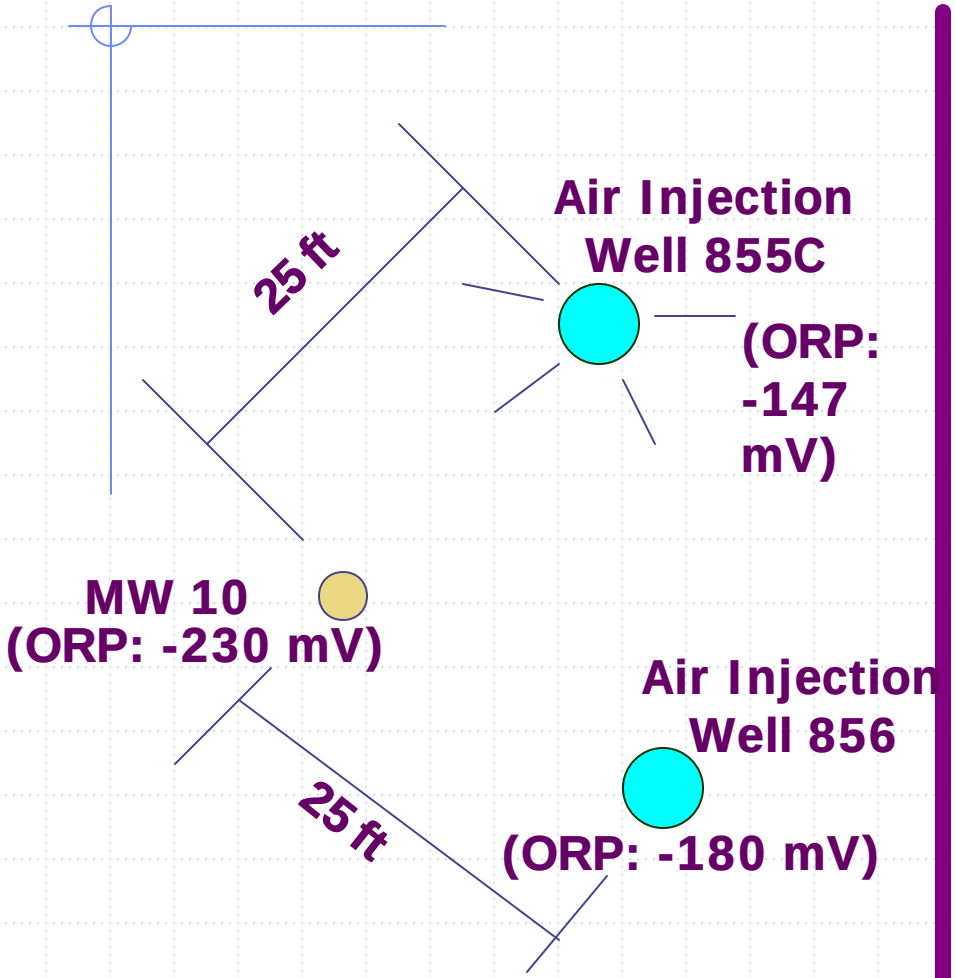
QUALITATIVE GAS CHARACTERIZATION

- **Typically, the decrease in CH_4 % is correspondingly followed by an increase in balance gas (i.e., primarily nitrogen gas) indicating that the gas overall in the area of the monitoring well is being diluted by the adjacent air injection wells**
- **There is some variability in how certain MWs respond to air injection. Variability is possibly due to fluctuations in moisture distribution and the limitations on Free Air Space (FAS)**
- **Certain wells (including MW 5) have exhibited "breakthrough" effects of air injection on gas character.**

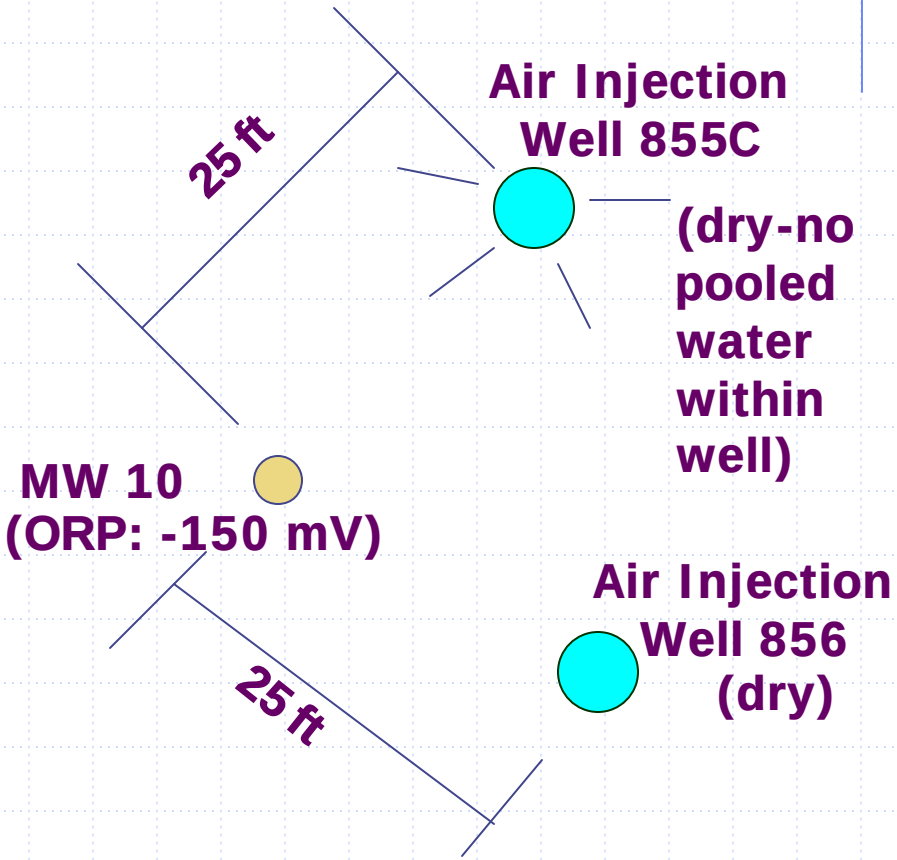
% CH_4 AND O_2 CHANGES RELATIVE TO AIR INJECTION - 2002 DATA

Monitoring Well Number	% CH_4 and Header Static Pressure At Initial Measurement At Time = 0	% CH4 and Header Static Pressure At Final Measurement At Time = t	Change In % CH_4 Relative To Value At Initial Measurement (Initial %-Final%) x 100 Initial %	Change In Residual % O_2 (Initial % – Final %)	Change In Air Header Static Back Pressure (Initial psig – Final psig)	Elapsed Time Between Readings (time, t)
1	**53%**	**28.5%**	**-46%**	**-0.9%**	**+1.4 psig (4.1 to 5.5)**	**2 weeks**
2	**42.2%**	**1.1%**	**-97%**	**+8.5%**	**+3.5 psig (1 to 4.5)**	**2 weeks**
3	**55%**	**12.1%**	**-78%**	**+2.4%**	**+1.4 psig (4.1 to 5.5)**	**2 weeks**
4	**55.6%**	**15.1%**	**-73%**	**+7.7%**	**+2.7 psig (1.8 to 4.5)**	**1 week**
5	**43%**	**10.6%**	**-75%**	**-0.9 %**	**+1.3 psig (4.2 to 5.5)**	**2 weeks**
6	**54.2%**	**27.2%**	**-50%**	**+1.8%**	**+1.3 psig (4.2 to 5.5)**	**2 weeks**
7	**53%**	**15.1%**	**-71.5%**	**negligible**	**No change**	**1 month**
8	**65.5%**	**11%**	**-83%**	**+1.6%**	**+2.5 psig (2.5 to 5 psig)**	**1 day**
9	**50.2%**	**9.3%**	**-81%**	**+7.6%**	**+4.0 psig (0.0 to 4 psig)**	**2 weeks**
10	**51.6%**	**1.1%**	**-98%**	**+8.9%**	**+2.4 psig (1.8 to 4.2 psig)**	**1 week**
11	**54.5%**	**5.4%**	**-90%**	**+16.4%**	**+4.8 psig (0.0 to 4.8 psig)**	**2 weeks**

CHANGES IN INTERNAL LEACHATE ORP RELATIVE TO RADIAL DISTANCE FROM AIR INJECTION WELL



Conditions When Air Header Backpressure At 3.5 psig



Conditions When Air Header Backpressure At 4.5 psig

SOLIDS DATA

- **Samples are taken approximately every 6 months via auger drilling. Frequency of sample events is dependant on how system operations have progressed**
- **Sample locations are chosen based on a grid system overlay of the reactor with designated x,y,z coordinates. Random number generator (based on uniform distribution) is utilized to chose sample locations for each event**
- **9 to 10 sample events will be ultimately performed. A set of 9 to 12 samples are taken per event, depending on the success of the drilling activity (i.e., adequate return of sample volume)**